federal register

Monday
September 29, 1980

Part VII

Department of Transportation

Federal Highway Administration
National Highway Traffic Safety Administration

Certification of Speed Limit Enforcement

DEPARTMENT OF TRANSPORTATION

Federal Highway Administration

National Highway Traffic Safety Administration

23 CFR Parts 658 and 659

Certification of Speed Limit Enforcement

AGENCIES: Federal Highway Administration (FHWA), National Highway Traffic Safety Administration (NHTSA), DOT.

ACTION: Final rule.

SUMMARY: This document sets forth the requirements for a 55-mile per hour national maximum speed limit and the monitoring of speeds to meet the criteria for compliance with the speed limit, including procedures for determining noncompliance and the consequences of such a determination.

DATES: This regulation is effective on October 1, 1980. The first certification under this regulation is due by December 31, 1981, covering the period October 1, 1980, to September 30, 1981. The initial speed sampling and analysis plan will be due on November 14, 1980. Subsequent annual evaluations of and proposed changes to the plan will be due on or before each December 1, beginning with December 1, 1981, so that changes to the plan called for by the evaluation can go into effect with the subsequent quarter beginning January 1.

FOR FURTHER INFORMATION CONTACT: William F. Bauch, FHWA, Office of Traffic Operations, (202) 426–1993, David C. Oliver, FHWA, Office of the Chief Counsel, (202) 426–0825, or John G. Womack, NHTSA, Office of the Chief Counsel, (202) 426–1834; 400 Seventh Street SW., Washington, D.C. 20590. Office hours are from 7:45 a.m. to 4:15 p.m. ET, Monday through Friday.

SUPPLEMENTARY INFORMATION: The FHWA and NHTSA have determined that this document contains a significant regulation according to the criteria established by the Department of Transportation (DOT) pursuant to Executive Order 12044. A regulatory evaluation is available for inspection in the public docket (FHWA Docket No. 78–41) and may be obtained by contacting Mr. William F. Bauch at the address specified above.

The annual certification of speed limit enforcement by the States became a mandatory requirement upon passage of the Federal-Aid Highway Amendments of 1974, Pub. L. 93–643, 88 Stat. 2281, which added a new Section 141 to title 23 of the United States Code (23 U.S.C.). Implementing regulations were published in the Federal Register on September 9, 1975, and codified as 23 CFR 658.7.

Section 205 of the Surface Transportation Assistance Act of 1978 (STAA), Pub. L. 95–599, 92 Stat. 2689, amended 23 U.S.C. 154 by establishing compliance levels against which to judge each State's performance in terms of the 55-mile per hour national maximum speed limit. The compliance levels are based upon a graduated system of standards which measure the effectiveness of State speed limit enforcement programs, utilizing the percentage of motor vehicles exceeding 55 miles per hour. The initial level of compliance was 70 percent for the 12-month period ending September 30, 1979 (requiring that no more than 70 percent of vehicles shall be exceeding 55 miles per hour). This level is reduced by 10 percent for each succeeding 12-month period until a level of 30 percent is reached, which is applicable for the 12-month period ending September 30, 1983, and for each 12-month period thereafter.

In addition, 23 U.S.C. 154 now specifies that the annual certification of speed limit enforcement required by 23 U.S.C. 141 will include:

> * * * data on the percentage of motor vehicles exceeding fifty-five miles per hour * * * including * * * criteria based upon the speeds of all vehicles or a representative sample of all vehicles.

This "all vehicles" requirement is in constrast to the "free flow" vehicle concept which has been the basis for the speed monitoring program since 1975. These changes necessitated a different approach in deriving the supporting speed data which each State is required to submit as a part of its annual certification of speed limit enforcement.

On September 27, 1979, FHWA and NHTSA published an amendment to the emergency final rule concerning certification and monitoring requirements for the national maximum speed limit. The comment period was open through January 4, 1980.

On November 5, 1979, the FHWA and NHTSA published a notice of proposed rulemaking (NPRM) setting forth the proposed requirements for the monitoring of speeds to meet the criteria for compliance with the national maximum speed limit, including procedures for determining noncompliance and the consequences of such a determination. Included in the NPRM was a copy of a draft Speed Monitoring Program Procedural Guide (SMPPG), which proposed a basis for a State to develop a speed sampling and analysis plan. The comment period was open through January 4, 1980.

Thirty comments were received on the two notices concerning the proposed modification of 23 CFR 658.7. Twenty-five comments were received from 21 public agencies, including State highway agencies and State police departments. Four agencies commented separately on the two notices. Additional comments were received as follows: two from citizens, one from a university, and two from associations.

Each of the public agencies commented on various aspects of the proposed rule, however, a recurring theme in many of the submissions was the general observation that the draft SMPPG and the procedures outlined therein were too detailed and administratively onerous, and that implementation of the procedures would require a commitment of personnel, equipment, and budget that States could ill afford in this era of decreasing availability of funds.

In developing these requirements, the FHWA and NHTSA have been cognizant of the points made in these responses. However, it was concluded that implementation of the "all vehicles" concept is a fundamental requirement of the law which does entail some additional administrative work. Uniformity in the collection and summarization of speed data has been given new importance in light of the system of penalties provided by 23 U.S.C. 154 for failure to meet the legally established criteria and the incentives for better performance than specified in the compliance criteria. Accordingly, the procedures in the Speed Monitoring Program Procedural Manual (SMPPM) issued as part of this regulation specify that all sampling plans and resultant statistics be weighted by factors which reflect the vehicle miles traveled (VMT) on highways posted with a 55-mile per hour speed limit (VMT at 55 mph). Use of VMT at 55 mph as a factor in the design and implementation of each State's speed monitoring plan will help accomplish two goals: (1) It will put the field monitoring effort where the traffic is, by emphasizing the high volume highways; and (2) it will produce a more representative sample of all vehicles as discussed in 23 U.S.C. 154.

Further, six State transportation agencies and the American Association of State Highway and Transportation Officials (AASHTO) recommended that we adopt procedures developed by a task force from the AASHTO Highway Subcommittee on Traffic Engineering. This procedure would replace the statistical procedures contained in the draft SMPPG and the SMPPM. The

AASHTO procedures would produce speed data that will be comparable between States rather than data based on a representative sample. Under such a procedure, each State would select eight control stations meeting the parameters established by AASHTO. Each State would assure that speed data are gathered from at least five of the eight control stations. Analysis of data between States would be limited to comparison of data from stations of the same type.

This approach is not acceptable. Comparability of speed data collection sites between States is not a requirement of the law, which is very specific in establishing compliance criteria for each year beginning with the 12-month period ending September 30, 1979. The sole measure of compliance in the law is the percent of vehicles exceeding 55 miles per hour based on a representative sample. Presumptively then, the speed data submitted by each State must stand the test of compliance or noncompliance without reference or relativity to submissions from other States. Because both penalties and incentive awards are determined by the compliance level, it has been concluded that the supporting speed limit enforcement data must have a minimum statistical confidence and reliability, which is provided by the procedure adopted in this regulation. The primary difference between the AASHTO approach and the FHWA/NHTSA approach to the problem is that AASHTO's method will provide comparable State-to-State data, but only for similar individual sites, while the FHWA/NHTSA approach will provide a representative statewide figure at a specified statistical confidence. The AASHTO method cannot produce statistical confidence in the statewide value.

To meet the test of sufficient accuracy without imposing unrealistic requirements on the States, particularly with respect to budget and staff, a number of factors were considered. In modifying the requirements provided in this final regulation, the following specific considerations were emphasized.

Mileage

Four State highway agencies (SHA's) commented on the use of highway functional groupings as the basis for establishing the network of speed monitoring locations. It was pointed out that significant rural mileages in the lowest functional classification originally proposed (rural minor collectors) are owned, maintained, and policed by various local jurisdictions, and are not under direct State agency control. While this fact alone is not a basis to exclude mileage from this program, considerations of travel and mileage data do provide a basis for eliminating this functional grouping from further involvement. Current data indicate that rural minor collectors with a 55 mph speed limit carry less than 3 percent of the total travel at 55 mph, even though the grouping comprises 18 percent of the total mileage at 55 mph. In addition, the State speed sampling and analysis plan called for in this regulation would, in part, require the acquisition of certain highway inventory data on these roads, which would involve the local jurisdictions, creating an unnecessarily involved and complicated data collection requirement for a highway grouping that in the end might only be subject to 2 or 3 percent of the total speed monitoring effort. A similar review of mileage and travel data for urban collectors with a 55 mph speed limit (.03 percent and .08 percent of the nationwide totals, respectively) leads to recognition of the fact that mileage in this functional grouping would not be a significant part of the speed monitoring program in any State. As a result, the deletion of rural minor collectors and all urban collectors will not adversely affect the goals of the speed monitoring program. Accordingly, the mileage to be included in each State's speed monitoring program will be broken down into the following six functional groupings:

Rural:
1. Interstate
2. Other Principal Arterials and Minor Arterials
3. Major Collectors

Urban:
1. Interstate
2. Other Freeways and Expressways
3. Other Principal and Minor Arterials

Number of Monitoring Locations

The formulas in the SMPPM for developing each State's initial year sample size (number of different locations to be monitored) require the use of a standard deviation of the percentage of vehicles exceeding 55 miles per hour between locations within the State for the specific type of sampling design to be used (in this case stratified cluster sampling). Because this specified type of sample design had not been used by any State, and historical data on "all traffic" were available from only one State, the draft SMPPG suggested the universal initial use of a standard deviation value of 12. During the past several months, additional "all traffic" data became available from a small number of States. Analysis of these data has allowed the refinement of this standard deviation value to 7.0. A modification in the assumed standard deviation value will considerably reduce the initial number of monitoring locations; however, it will also increase the probability that some States will have to increase their sample size after the first year's data are analyzed. These considerations must be balanced against the need to have each State revise its speed monitoring programs in accordance with more uniform procedures. Thus, the SMPPM now recommends the universal use of the 7.0 value for standard deviation for calculating the initial year's sample size.

The reduction in effort brought on by revising the initial standard deviation value has led to an additional modification. The sampling design target precision is being increased from $\pm^{25}$ percent to $\pm^{20}$ percent. This change will reduce the sampling uncertainty surrounding the estimate of the percent exceeding 55 mph.

These changes will reduce by approximately one-half from the procedures in the NPRM the speed data collection effort required of the States.

The above changes effect the determination of sample size based on an accuracy required. To compensate for additional variables between States, e.g., variations in mileage, travel enforcement effort, etc., each State is also required to compute a minimum sample size based on the coverage of population sampled concept. This concept requires each State to divide its statewide total daily vehicle miles of travel (DVMT) subject to a 55 mph speed limit by an administratively chosen value that represents a best effort to balance the required State monitoring effort against the need to ensure that speed data represent the wide range of travel, topography, geometrics, enforcement, etc., present in the various States. The NPRM provided a value of 1 million (DVMT per location), which is increased to 2 million under the procedures incorporated in this regulation.

These considerations of sampling size are based on the retention of the 5 mile sampling frame segment length discussed in the NPRM.

Statistical Submissions

The percent of vehicles exceeding 55 miles per hour is the sole value by which compliance with the specified standards in the law will be established. Accordingly, this is the only value which must accompany the annual certification of speed limit enforcement. However, the Secretary must also make an annual judgment regarding each State's

adequacy of enforcement of the speed limit. This adequacy of enforcement decision is separate from the compliance judgment and is a much more subjective decision. The more complete the information available, the less subjective an ultimate decision will be. In this respect, the quarterly submission of data by each State during the past 4 years has provided valuable information concerning driver behavior on the basis of the six data elements contained therein, including the average speed, median speed, 85th percentile speed, and percent exceeding 55, 60, and 65 miles per hour, respectively. To assure the availability to the Secretary of sufficient data to assist in the adequacy of enforcement judgement, this regulation requires that each State continue to submit quarterly summaries of the six data elements listed above. The concept of standard and control sampling locations described in the NPRM is retained: the percent exceeding 55 mph will be derived from all locations, while the other five items, i.e., average, median, and 85th percentile speed, and the percent exceeding 60 and 65 mph, will be derived (as a minimum) only from the control sampling locations. In order to balance the overall reduction in locations resulting from the statistical changes described earlier against the need to have all States supply the other five data items with some degree of statewide representativeness, the number of control sampling locations per highway grouping has been increased from 20 percent or a minimum of 1 to 33⅓ percent or a minimum of 2.

Locating Speed Monitoring Sites

Six commenters expressed concern about using a strictly random method of selecting speed monitoring sites. Four States expressed the desire to be able to locate at least some of their required speed monitoring locations at sites that may already be instrumented for other data collection purposes. This concept is worthwhile, especially from the standpoint of more efficient use of staff and equipment. However, the random selection concept is one of the keystones upon which statistical accuracy has been built and cannot be compromised in every case. Accordingly, this regulation allows a reasonable accommodation between the two concepts, but only with regard to the location of control sampling sites. All standard sampling locations will continue to be chosen in accordance with the random selection principles described in the SMPPM.

The FHWA has implemented the Highway Performance Monitoring System (HPMS) as a continuing information system encompassing data collection, extensive data analysis and modeling, and historical recordkeeping. The HPMS provides the FHWA and the States with a framework for the efficient collection of highway planning and performance data for use in: (1) Periodically assessing the extent and condition of the highway systems; (2) monitoring the performance of the highway systems on a continuing basis; (3) calculating the impacts of existing highway programs and policies; and (4) forecasting potential impacts of future alternative programs and policies.

As part of this effort to promote the efficient collection of highway related data, the location of speed monitoring stations will be coordinated with the HPMS to the extent possible. Speed monitoring control stations (at one-third of all locations and approximately 70 percent of all monitoring sessions) will be located on HPMS sample sections. Where the location of a randomly selected control station falls near an HPMS section, the location should be moved to the HPMS section (see SMPPM for details). If this is not feasible, the highway section containing the speed control location should be added to the HPMS panel of sample sections. For the foreseeable future, the remaining speed monitoring sites (standard locations) for annual collection of data will be located without regard to HPMS sections.

Speed Sampling Period Duration

Eleven SHA's commented on the timetable for implementing the data collection function delineated in the draft SMPPG. Some States pointed to budgetary processes and to purchasing regulations which would prevent the acquisition of speed monitoring equipment with 24-hour capability between the date of publication of the final regulation and October 1, 1980. Other States expressed a desire to have the benefit of the findings of an ongoing FHWA study of speed monitoring equipment ("Evaluation of Speed Monitoring Systems") before making any purchase decisions. Some States did indicate a general acceptance of the October 1, 1980, implementation date.

Section 154 of title 23, U.S.C., specifies that the data be "based on speeds of all vehicles or a representative sample of all vehicles." The "all traffic" phrase has been interpreted to mean 24-hour traffic volumes; the draft SMPPG was developed accordingly. Most of the States intend to meet the 24-hour requirement by the acquisition and use of unattended equipment that would automatically record the speeds of all vehicles, although the SMPPM does not require unattended equipment. Because of the aforementioned comments relative to equipment acquisition, some States will have difficulty in acquiring 24-hour speed data by use of unattended equipment and will continue to rely on manual data collection methods. For those cases, this regulation includes an alternative data collection plan that a State can implement, upon approval by the FHWA Division Administrator, during Fiscal Year (FY) 1981 only. Beginning with FY 1982, the length of all sessions must be 24 hours irrespective of the data collection method employed.

Speedometer Variability

Section 154 also requires that a determination of compliance or noncompliance take into account the variability of speedometer readings. As initially published in emergency form, the speed monitoring guidelines were not adjusted to account for any variability. This regulation continues that status. In the near future, a document describing the methodologies available to achieve this goal will be published and distributed.

The States are encouraged, but not required, to analyze the monitoring data with an eye toward the various error factors that exist in this type of data collection. As a supplement to the annual certification, a State may submit an adjusted figure for the percent exceeding 55 resulting from that State's determination of the applicability and magnitude of an error factor. Any such submission should make very clear the base percent exceeding 55 mph figure (derived from the speed monitoring program), the amount of any adjustment(s), their application, and derivation. In addition to speedometer variability, these error factors can include, but are not limited to, statistical error and measurement error.

As an example, there are at least two elements that would be needed in any speedometer variability adjustment process: (1) speedometer error distributions of vehicles and (2) a freqency distribution of vehicle speeds. Likewise, the statistical error that is inherent to any result of a sampling plan would require computation of the sample standard deviation. Any speed measuring equipment error that a State can determine exists should also be documented and made available to the Secretary.

The States are invited to submit all pertinent information as all available input will be utilized in making a compliance determination.

Finally, the 1978 STAA amendment to the 55 mph national maximum speed

limit requires that two determinations now be made: The adequacy of enforcement and the level of noncompliance. No criteria are provided in the statute for determining the amount of penalty applicable, particularly with respect to the level of noncompliance which requires a withholding of Federal-aid highway funds of up to 5 percent in Fiscal Years 1981, 1982, or 1983 (based on compliance in Fiscal Years 1979, 1980, or 1981), and up to 10 percent in Fiscal Year 1984 and subsequent fiscal years. However, the following considerations are among the factors which will be taken into account in determining the amount to be withheld for noncompliance with the requirements of the statute:

A. Extent of Noncompliance—The amount of the penalty will be influenced by the degree to which a State's motorists exceed the 55 mph speed limit. For example, a State with more than 10 percent of its motorists in excess of the specified level will be more likely to incur a withholding of a greater portion of funds than a State which has almost met the specified compliance level. Likewise, speed trends will also be considered, both historically and over the course of the year in which the State has failed to meet the specified level.

B. Quality of a State's 55 MPH Legislation—The commitment of a State to enforce the speed limit will be considered. This commitment is presumptively reflected in the State's laws and budget priorities. Minimum penalties or no penalties as established by the legislature are important factors. Other factors include: the assessment of points on the driver's license of violators; whether penalties are less severe than provided prior to the establishment of the 55 mph speed limit; and prohibitions imposed by law or policy inhibiting effective enforcement, e.g., prohibition on the use of radar for enforcement.

C. Maintenance of Compliance Activities at an Adequate Level—The use of resources including funds available to promote compliance with the speed limit. This factor incorporates a number of considerations including reductions or increases in the number of arrests and citations; the magnitude of public information efforts; and the utilization of police on 55 mph assignments.

D. Miscellaneous Considerations—Other factors which will be considered include: Usage of speed monitoring data by the State police; enforcement methodologies, including innovative techniques; the involvement of other governmental agencies in enforcement efforts; methods utilized to enhance and maintain proficiency of enforcement officers; efforts to gain support of the judiciary in penalizing violators; licensing procedures to discourage violations; and efforts to gain the support of companies/agencies having control over fleets of vehicles.

These considerations will form the basis not only in determining the amount of penalty, but also in informal resolution of questions which arise from the certification review process. This regulation provides a method for such informal resolution, and utilization of this procedure is encouraged. Also provided is a procedure for an informal conference at which an explanation and offer of settlement within the context of the above factors may be made. This regulation also clarifies the right of the States to secure formal administrative procedures to resolve such matters.

Because the current emergency rule concerning certification and monitoring requirements for the national maximum speed limit expires September 30, 1980, and because the next statutory certification period begins October 1, 1980, this rule will be effective October 1, 1980.

In consideration of the foregoing, Chapter I of Title 23, Code of Federal Regulations, is amended by removing Part 658 and by adding a new Part 659 as set forth below.

Issued on: September 24, 1980.

Joan Claybrook,
National Highway Traffic Safety Administrator.

John S. Hassell, Jr.,
Federal Highway Administrator.

PART 658—[REMOVED]

1. Remove Part 658 from Chapter I of Title 23, Code of Federal Regulations.

2. Add a new Part 659 to Chapter I of Title 23, Code of Federal Regulations, to read as follows:

PART 659—CERTIFICATION OF SPEED LIMIT ENFORCEMENT

Sec.

659.1 Purpose.
659.3 Objective.
659.5 Definitions.
659.7 Adoption of a national maximum speed limit.
659.9 Formulation of a plan for monitoring speeds.
659.11 Guidelines and evaluations of operations.
659.13 Certification requirement.
659.15 Certification content.
659.17 Certification and statistical submittal.
659.19 Effect of failure to certify or to meet compliance standards.
659.21 Procedure for the reduction of funds.
Appendix—Speed Monitoring Program Procedural Manual.

Authority: 23 U.S.C. 141, 154, 315; sec. 205, Surface Transportation Assistance Act of 1978, Pub. L. 95–599, 92 Stat. 2689; 49 CFR 1.48(b) and 1.50.

§ 659.1 Purpose.

To prescribe requirements for administering a program for monitoring speeds on public highways in order to provide reliable data to be included in a State's annual certification of speed limit enforcement.

§ 659.3 Objective.

To establish a valid statistical method of measuring a sample of vehicle speeds on a sample of highways to estimate the percentage of vehicles exceeding 55 miles per hour (mph) with sufficient accuracy to support a determination of compliance with 23 U.S.C. 154. A secondary objective is to quantify the overall statewide distribution of speeds by comparing other characteristics which may indicate the level of enforcement or public compliance, such as average speed, median speed, 85th percentile speed, and percentages of vehicles exceeding 60 and 65 miles per hour.

§ 659.5 Definitions.

As used in this part:

(a) "State" means any one of the 50 States, the District of Columbia, or Puerto Rico.

(b) "Highway" means all streets, roads or parkways under the jurisdiction of a State, including its political subdivisions, open for use by the general public, and including toll facilities.

(c) "Motor vehicle" means any vehicle driven or drawn by mechanical power manufactured primarily for use on public highways, except any vehicle operated exclusively on a rail or rails.

(d) "Posted" means those roads with a legal speed limit of 55 mph, excluding any unpaved roads and roads in the following functional classifications: Urban collector and local streets; rural local roads; and rural minor collectors. This includes both State-maintained and non-State-maintained roads, including toll roads.

§ 659.7 Adoption of a national maximum speed limit.

The Secretary of Transportation shall not approve any Federal-aid projects under 23 U.S.C. 106 in a State which fails to adopt or maintain maximum speed limits as follows:

(a) The maximum speed limit on any highway in the State shall be 55 mph or less, except that emergency and police motor vehicles may be authorized to operate at higher speeds when necessary to protect the public health or safety.

(b) Except as provided in paragraphs (c) and (d) of this section, the speed limit on any portion of a highway shall be uniformly applicable to all types of motor vehicles using such portion of highway, if on November 1, 1973, such portion of highway had a speed limit which was uniformly applicable to all types of vehicles using it.

(c) Notwithstanding the provisions of paragraph (b) of this section, a State may establish a lower speed limit for a motor vehicle operating under a special permit because of weight or dimension of such vehicle, including any load thereon.

(d) Nothwithstanding the provisions of paragraph (b) of this section, a State may specify nonuniform speed limits on any portion of a highway when the condition of the highway, weather, an accident, or other condition creates a temporary hazard to the safety of traffic on such portion of a highway.

§ 659.9 Formulation of a plan for monitoring speeds.

(a) Each State shall develop a speed sampling and analysis plan following the guidelines set forth in the *Speed Monitoring Program Procedural Manual,* (SMPPM).

(b) The plan shall discuss the following subjects as a minimum:

(1) Functional grouping of highways to be used:

(i) The functional class groupings of highways will be used to distribute the monitoring effort.

(ii) The groupings of functional classes of highway for the speed monitoring program shall be: *urban* (Interstate, other freeways and expressways, and other principal and minor arterials) and *rural* (Interstate, other principal and minor arterials, and major collector roads).

(2) Miles of highway with a 55 mph speed limit, by functional group:

(i) Miles of highway with a 55 mph speed limit shall be used in the selection of speed monitoring locations.

(ii) The proportion of paved highway mileage in each grouping subject to the 55 mph speed limit shall be determined by each State.

(3) Distribution of travel (VMT or DVMT) on highways with a 55 mph speed limit. The VMT by functional system shall be used to distribute the data collection effort and in the calculation of the statewide percent of vehicles exceeding 55 mph.

(4) Sources of speed data used in calculating sample size (default values or data from previous monitoring).

(5) Number of sampling locations and sessions and their distribution by system and geographic area, all of which shall be determined in accordance with the SMPPM. A sampling session shall consist of a single period of monitoring at a partiular place (sampling location).

(i) The minimum sample size needed by each State shall be determined under both (A) the accuracy of statistical estimates concept and (B) the coverage of population sampled concept. Both concepts are fully explained in the SMPPM. The larger of the two numbers shall be used as the statewide minimum sample size.

(ii) A 24-hour monitoring period shall be required for individual sampling sessions beginning with FY 1982. During FY 1981, an alternative to the 24-hour session will be allowed as follows. With the approval of the FHWA Division Administrator, a State may, for FY 1981 only, substitute a minimum 3-hour data collection session during which the speeds of all vehicles passing the sampling location in at least one direction shall be recorded. The State's request to use the reduced session shall be accompanied by a schedule which shows that sessions will be scheduled, as a minimum, to cover the entire normal work day of the State. The State's request shall also include a report of the steps being taken to implement 24-hour monitoring.

(6) Type and capabilities of speed measuring equipment to be used.

(7) Data collection.

(i) Schedule—a detailed schedule shall take into account day of the week, month, and season of the year.

(ii) Field data collection—the goal is to obtain, during each monitoring session, a representative record of the traffic speeds that normally occur in a given segment. Therefore, the choice of a data collection site within a given segment should reflect the geometric design conditions of the segment. In addition, the collection of data should not be attempted if conditions at a site are such that the normal flow of traffic is substantially restricted.

(8) Any deviation from the analysis methods described in the SMPPM.

(c) the guidelines set forth in the SMPPM rely on many assumptions. After a complete year's data are available, and thereafter on an annual basis, the plan shall be evaluated to determine its effectiveness in meeting the objective of the speed monitoring program. As a minimum, the evaluation shall discuss:

(1) The actual accuracy level obtained with regard to the statewide value for the percent exceeding 55 mph.

(2) Adjustments to the number of sampling locations in a State, necessary to achieve the target sampling accuracy called for in the SMPPM.

(3) The validity of the travel figures (vehicle miles of travel (VMT) or daily vehicle miles of travel (DVMT)) used.

(4) Any other changes to the plan proposed by the State.

§ 659.11 Guidelines and evaluations of operations.

The State shall submit its initial plan to the FHWA Division Administrator for approval by November 14, 1980. The plan shall be evaluated annually and revised as conditions and new data indicate. These evaluations shall be submitted to the FHWA Division Administrator for approval by December 1 following the close of the data collection period of each year beginning with December 1, 1981, so that changes to the plan called for by the evaluation can go into effect with the subsequent quarter beginning January 1.

§ 659.13 Certification requirement

Each State shall certify to the Secretary of Transportation before January 1 of each year that it is enforcing the 55-mph National Maximum Speed Limit on all public highways in accordance with 23 U.S.C. 154. The certification shall be supported by information on activities and results achieved during the 12-month period ending on September 30 preceding the January 1 date by which certification is required.

§ 659.15 Certification content.

The certification shall consist of the following elements:

(a)(1) A statement by the Governor of the State, or an official designated by the Governor, that the 55-mph National Maximum Speed Limit on public highways in the State is being enforced. The certifying statement shall be worded as follows:

"I, (name of certifying official), (position title), of the (State or Commonwealth) of ————, do hereby certify that the (State or Commonwealth) of ———— is enforcing the 55-mph National Maximum Speed Limit.".

(2) If this statement is made by an official other than the Governor, a copy of the document designating the official, signed by the Governor, shall also be included in the first certification made under this part. This designation shall remain valid as long as the Governor or the designated official remains in the respective positions. A new designation will be required with the first certification due after either official leaves his/her position.

(b) A copy of any State law, regulation, administrative order, statement of policy or any other written instruction relating to enforcement of

the 55-mph National Maximum Speed Limit, which has not been included in earlier certifications, or a statement that there have been no changes to any such documents previously submitted. If a written enforcement agency policy on the 55 mph speed limit does not exist, a statement to that effect must also be included.

(c) Information relating to enforcement and monitoring as follows:

(1) Miles of highway with a 55 mph speed limit, by functional group.

(2) The number of citations issued by State agencies for violation of the 55 mph speed limit during each month of the 12-month period ending on September 30 before the date by which certification is required.

(d) The statewide percentage of vehicles exceeding the 55 mph speed limit weighted by the proportion of statewide 55 mph VMT on each of the six highway functional groupings.

§ 659.17 Certification and statistical submittal.

(a) The Governor, or an official designated by the Governor, each year shall submit the certification to the local FHWA Division Administrator. The FHWA Division Administrator shall retain the original and forward two copies each to the Regional Administrator of NHTSA and FHWA. The Regional Administrators shall each retain one copy and forward one copy of the submission, with any pertinent comments, to their respective Washington Headquarters, attention of the Chief Counsel.

(b) Any changes to the original certification or supplemental information necessitated by the review of the certifications as they are forwarded shall be submitted in the same manner as the original (see § 659.17(a)).

(c) As described in § 659.15(d), the statewide percentage of vehicles exceeding 55 mph is the only direct result of the speed monitoring program that is required for inclusion in the annual certification. However, additional summary statistics from the speed monitoring program will also be required. A report of the average speed, median speed, 85th percentile speed, and percent of vehicles exceeding 55, 60, and 65 miles per hour shall be submitted by each State to the FHWA Division Administrator on a quarterly basis for the 3-month periods ending December 31, March 31, June 30, and September 30 of each year. The report covering the July-September quarter shall be a summary encompassing the entire year's data (starting from the previous October 1).

§ 659.19 Effect of failure to certify or to meet compliance standards.

(a) If a State fails to certify as required by § 659.13 or if the Secretary determines that a State is not adequately enforcing the 55-mph National Maximum Speed Limit on all public highways notwithstanding the State's certification, no Federal-aid highway project shall be approved under 23 U.S.C. 106 in that State.

(b) Beginning with the certification submitted before January 1, 1980, for the 12-month period ending September 30, 1979, in those States whose certification indicated that the percentage of motor vehicles exceeding 55 mph was greater than 70 percent, the State's apportionment of Federal-aid highway funds under 23 U.S.C. 104(b)(1), 104(b)(2), and 104(b)(6) would have been reduced in an aggregate amount of up to 5 percent of the amount to be apportioned for the fiscal year ending September 30, 1981. The following schedule will apply to subsequent years:

(1) If the certification of January 1, 1981, shows a percentage exceeding 55 mph greater than 60 percent, an aggregate amount of up to 5 percent of apportioned funds for the fiscal year ending September 30, 1982, shall be withheld.

(2) If the certification of January 1, 1982, shows a percentage exceeding 55 mph greater than 50 percent, an aggregate amount of up to 5 percent of apportioned funds for the fiscal year ending September 30, 1983, shall be withheld.

(3) If the certification of January 1, 1983, shows a percentage exceeding 55 mph greater than 40 percent, an aggregate amount of up to 10 percent of apportioned funds for the fiscal year ending September 30, 1984, shall be withheld.

(4) If the certification of January 1, 1984, and each succeeding year shows a percentage exceeding 55 mph greater than 30 percent, an aggregate amount of up to 10 percent of apportioned funds for the fiscal year ending September 30, 1985, and each succeeding fiscal year thereafter shall be withheld.

(c) Where a reduction in apportioned funds pursuant to paragraph (b) of this section will result in a hardship to a State, the fiscal year apportionment reduced for such State shall be the apportionment for one fiscal year later than set forth in paragraph (b) of this section. The State must submit a claim of hardship in writing supported by sound reasoning and indications that corrective or remedial measures are to be undertaken to improve the State's compliance posture. Hardship under this paragraph relates to adverse impacts (e.g., economic or environmental) which would result from a delay in the letting of Federal-aid highway projects.

(d) Funds withheld pursuant to paragraph (b) of this section shall be apportioned to a State upon a determination that the percentage of motor vehicles in such State exceeding 55 mph has dropped to the level specified for the fiscal year in which speed monitoring results lead to funds being withheld. Such a determination shall be made on the basis of the following year's monitoring results.

§ 659.21 Procedure for the reduction of funds.

(a) In addition to the procedure set forth in § 659.19(b) for a State which fails to meet the specified compliance standards, if a State has not submitted a certification conforming to the requirements of this part, or the State is not adequately enforcing the 55-mph National Maximum Speed Limit, the FHWA and NHTSA Administrators shall make, in writing, a proposed determination of nonconformity, and shall notify the Governor of the State of the proposed determination by certified mail. The notice shall state the reasons for the proposed determination and inform the State that it may, within 20 days from the date of the letter, request a hearing to show cause why it should not be found in nonconformity. If the State informs the Administrators before the end of the 20-day period that it wishes to attempt to resolve the matter informally, the Administrators may extend the time for requesting a hearing by an additional 20 days. In the event of a request for informal resolution, the State and the Administrators (or designees) shall promptly schedule a meeting to resolve the matter.

(b) In all instances where the State proceeds on the basis of informal resolution, a transcript of the conference will be made and furnished to the State by the FHWA or NHTSA.

(1) The State may offer any information which it considers helpful to a resolution of the matter, and the scope of review at the conference will include, but not be limited to, legislative actions, including those proposed to remedy deficiencies, budgetary considerations, judicial actions, and proposals for specific actions which will be implemented to bring the State into compliance.

(2) The information produced at the conference may constitute an explanation and offer of settlement and the Administrators will make a determination on the basis of the certification, record of the conference, and other information submitted by the

State. The Administrators' final decision together with a copy of the transcript of the conference will be furnished to the State.

(3) If the Administrators do not accept an offer of settlement made pursuant to paragraph (b)(2) of this section, the State retains the right to request a hearing on the record pursuant to paragraph (d) of this section.

(c) If a State does not request a hearing in a timely fashion as provided in paragraph (a) of this section, the Administrators shall forward the proposed determination to the Secretary. Upon acceptance of the determination by the Secretary, the provisions of § 659.19(a) shall take effect immediately.

(d) If a State requests a hearing, the Secretary shall expeditiously convene a hearing on the record, which shall be conducted according to the provisions of the Administrative Procedure Act, 5 U.S.C. 551 et seq. Based on the record of the proceeding, the Secretary shall determine whether the State is in nonconformity with this part. If the Secretary determines that the State is in nonconformity under the provisions of § 659.19(b), the Administrators shall jointly notify the Governor of the State of the determination of nonconformity and of the proposed reduction in apportioned funds. The Governor shall also be informed that the State may request (within 20 days from the date of the letter) a delay in the penalty on the basis of hardship pursuant to § 659.19(c). While no hearing shall be extended on the question of nonconformity, the State may request an informal meeting to discuss the proposed amount of the withholding and the hardship request, if any. In the event of a request for such an informal meeting, the State and the Administrators (or designees) shall promptly schedule a meeting to resolve the matter. No later than 60 days following the meeting, a final determination shall be made with regard to the amount of the withholding and the hardship request, if any.

Appendix.—Speed Monitoring Program Procedural Manual for the National Maximum Speed Limit, May 1980.

U.S. Department of Transportation, Federal Highway Administration, Program Management Division, Procedural Development Branch, Washington, D.C. 20590

Table of Contents

Chapter
I Introduction.
Background.
Purpose.
Legislation.
Objective.
Development and Documentation of Sampling Plan.
II Sampling Plan Prerequisities.
Functional Grouping of Highways.
Miles of Highway with a 55 M.P.H. Speed Limit.
Distribution of Travel (VMT) on Highways with a 55 M.P.H. Speed Limit.
III Sampling Guidelines.
Overview of Sampling Plan.
Statistical Criteria for Sample Design.
Length of Monitoring Period for Individual Sampling Sessions.
Minimum Number of Statewide Sampling Locations.
Minimum Sample Size Based on Reliability Requirement.
Minimum Sample Size Based on Coverage of Population Sampled.
Allocation of Sampling Locations by Highway Functional Grouping.
Selection of Highway Sample Segments.
Construction of the Sampling Frames.
Selection of Sample Segments.
Development of Annual Sampling Plans.
IV Data Collection.
Organization.
Scheduling the Data Collection.
Field Data Collection.
Review Highway Conditions.
Location of Monitoring Station.
Speed Monitoring Systems.
Procedures for Obtaining and Recording Data.
1. Recording Equipment.
2. Nonrecording Equipment.
V Data Analysis and Sample Design Evaluation.
Computation of Statistics Related to the Percentage Exceeding 55 M.P.H.
Percentage Exceeding 55 M.P.H. by Highway Grouping.
Statewide Percentage Exceeding 55 M.P.H.
Standard Deviation of Estimates by Highway Grouping.
Statewide Standard Deviation Estimate.
Reliability of Statewide Estimates.
Sample Size Determination Based on Data Analysis.
Computation of Other Statistics.
Session Average or Mean Speed
Session Median Speed.
Session 85th Percentile Speed.
Highway Functional Grouping and Statewide Estimates
Specialized Analysis.
VI Reporting Results.

I. Introduction

Background

The national 55 m.p.h. speed limit was first instituted as a temporary conservation measure in response to the severe fuel shortage that occurred in late 1973. The significant reduction in travel speeds and the accompanying decline in traffic fatalities prompted Congress to establish the national 55 m.p.h. speed limit as a permanent measure. The Federal-Aid Amendments of 1974 made annual State enforcement certification a prerequisite for approval of Federal-aid highway projects. Summary data from comprehensive speed monitoring programs have been part of these annual State certifications.

The "Procedural Guide for Speed Monitoring," issued in September 1975, provided guidelines for monitoring speeds to determine the level of motorist compliance with the speed limit. Data were to be collected on level, tangent highway sections under "free-flow" conditions. The original speed monitoring procedures were designed to produce statistics for each of five highway types in a State. Predictably, a desire arose for Statewide statistics representative of conditions on all highway types. Methods for calculating Statewide statistics varied among the States, making the value of State-to-State comparisons questionable.

Slowly declining compliance with the 55 m.p.h. speed limit and increasing accident and fatality rates prompted the Department of Transportation (DOT) to recommend and the Congress to approve significant changes in the speed limit legislation in 1978. The Highway Safety Act of 1978 provides for both withholding Federal-aid highway funds and awarding incentive grants based on speed compliance data submitted annually. The major data requirement in each State is now an estimate of the percent of motor vehicles exceeding 55 m.p.h. which is representative of travel on roads and streets having legal speed limits of 55 m.p.h. "Interim Speed Monitoring Procedures," issued in December 1978, contains instructions for collecting and reporting speed information on these roads and streets for fiscal years 1979 and 1980.

Purpose

The speed monitoring program is primarily intended to provide reliable data to be included in a State's annual certification of 55 m.p.h. speed limit enforcement. In addition, the data may be used to evaluate:

- Motorist compliance with the 55 m.p.h. speed limit.
- The effectiveness of various enforcement strategies.
- The effectiveness of various public awareness programs.
- Speed trends.

The 1978 legislation necessitated major changes from earlier monitoring programs. Procedures presented in this manual include:

- Requirements that a Statewide figure for "percent of motor vehicles exceeding 55 m.p.h." be developed that represents Statewide travel on all systems of highways with limits of 55 m.p.h., not just for individual systems.
- "Free-flow" will no longer be the only condition monitored. Speed statistics must be representative of all

travel; thus, all vehicles passing a monitoring station during the observation period must be measured.

• Speeds may now be monitored on other than level, tangent sections of highway.

• Previously, speed monitoring was conducted under rather ideal weather conditions. Although future monitoring during snow conditions is discouraged, wet, damp or rainy weather will no longer be disqualifying.

Legislation

Section 205 of the "Surface Transportation Assistance Act of 1978" (Title II known as the Highway Safety Act of 1978) is the basis for speed monitoring activities related to the national maximum speed limit (55 m.p.h.). Table I–1 summarizes required levels of speed limit compliance and the consequent Federal-aid withholding or incentive grants. The speed monitoring guidelines presented in this manual outline a statistical sampling approach which will provide speed data with an accuracy reasonable for administering the law.

Objective

The objective of this manual is to establish a valid statistical method of measuring a sample of vehicle speeds on a sample of highways in order to comply with the requirements specified in Section 154 of Title 23, United States Code, as amended. The law defines compliance in terms of the statewide "percentage of motor vehicles exceeding 55 m.p.h." on public highways with speed limits of 55 m.p.h. Therefore, the main objective of the speed monitoring program is to estimate this percentage with sufficient accuracy to allow a determination of compliance. However, an estimate of the percentage of vehicles exceeding 55 m.p.h. is not sufficient to quantify the overall statewide distribution of speeds. Other important characteristics that may indicate the level of enforcement of public compliance are average speed, median speed, percentages exceeding 60 or 65 m.p.h., etc.

The legislation is very specific that the percentage exceeding 55 m.p.h. is the statistic to be used in judging compliance. In order to estimate the distribution of speeds, it is necessary to collect somewhat different data than is required to estimate the percentage exceeding 55 m.p.h. The accuracy of these other statistics that may be developed need not require as high a level of accuracy and, therefore, is not a controlling factor in designing a sampling plan.

Development and Documentation of Sampling Plan

Following the guidelines in this manual, each State shall develop a speed sampling and analysis plan for approval by the FHWA Division Administrator. The plan shall be reviewed annually and updated as conditions and new data indicate. As a minimum, the initial plan shall include:

• Functional grouping of highways to be used.

Table I-1

Statutory Level of Speed Limit Compliance for Sanctions or Incentive Grants

For Period Ending	Sanctions		Incentive Grants	
	% Exceeding 55 m.p.h.	Amount Withheld[1/]	% Exceeding 55 m.p.h.	Amount of Grant[2/]
9/30/79	>70%	5%	<60%	10%
9/30/80	>60%	5%	<50%	10%
9/30/81	>50%	5%	<40%	10%
9/30/82	>40%	10%	<30%	10%
9/30/83 and thereafter	>30%	10%	<20%	10%

1/ Federal-aid highway funds under Sections 104 (b) (1), 104 (b) (2), and 104 (b) (6) of Title 23 (excluding Interstate).

2/ Incentive grant shall be equal to 10% of the apportionment made under Section 402 (c). Grants may be used for carrying out any provision of Section 402, Title 23.

- Miles of highway with a 55 m.p.h. speed limit, by functional group.
- Distribution of travel (VMT or DVMT) on highways with a 55 m.p.h. speed limit.
- Sources of speed data used in calculating sample size (default values or data from previous monitoring).
- Number of sampling locations and sessions and their distribution by system and geographic area.
- Type and capabilities of speed measuring equipment to be used.
- Data collection schedule.
- Any deviation from analysis methods recommended in this manual.

II. Sampling Plan Prerequisites

The four types of data that must be assembled before a sampling plan can be developed are:

1. Functional class grouping of highways.
2. Miles of highway, by functional grouping, with a 55 m.p.h. speed limit.
3. Distribution of vehicle miles of travel, by functional grouping, on highways with a 55 m.p.h. speed limit.
4. Location of Highway Performance Monitoring System (HPMS) sample sections.

Functional Groupings of Highways

The functional class grouping of highways will be used in the speed monitoring program to distribute the monitoring effort. Public highways will be stratified based on the functional classification defined in the FHWA publication *Highway Functional Classification, Concepts, Criteria, and Procedures.* Some of the functional classes have been combined. The roadways to be monitored will be limited to those with a legal 55 m.p.h. speed limit. As a practical matter it has been administratively determined that any facilities functionally classified as "local" and any unpaved roads with a 55 m.p.h. speed limit shall be excluded from the speed monitoring program. The use of speed monitoring equipment on unpaved facilities is generally impractical and the relative amount of travel on local facilities is quite small.) In addition, rural minor collectors are estimated to carry less than 3 percent of the total travel at 55 m.p.h. Since these roads would require an insignificant amount of the monitoring effort and are generally under the control of local jurisdictions making acquisition of highway inventory data complicated, they have not been included in the monitoring program. For similar reasons, urban collectors carrying .08 percent of the applicable travel have also been excluded. The groupings of functional classes of highways for the speed monitoring program are:

Urban

- Interstate.
- Other freeways and expressways.
- Other principal arterials and minor arterial street systems.

Rural

- Interstate.
- Other principal arterials and minor arterial road systems.
- Major collectors.

Miles of Highway With a 55 M.P.H. Speed Limit

Miles of highways with a 55 m.p.h. speed limit will be used in the random selection of speed monitoring locations. Mileage by functional system has been determined in conjunction with the Federal-aid system realignment in 1976 and was reported to FHWA as part of the 1976 National Highway Inventory and Performance Study (NHIPS). During 1979, similar data was prepared by the States as part of the Highway Performance Monitoring System (HPMS). Most States report mileage by functional classification under FHWA's Mileage Facilities Reporting System (MFRS). Determining the miles of highway in each grouping of functioning highway classes should be a relatively straightforward process. The next step is to determine what proportion of the paved mileage in each grouping is subject to the 55 m.p.h. speed limit. This can be accomplished by reviewing roadway section logs or other inventory records that provide speed limit by roadway segment. It may be desirable to display this information on a State map for reference later.

Distribution of Travel (VMT) on Highways With a 55 M.P.H. Speed Limit

The VMT by functional system will be used to distribute the data collection effort and in the calculation of the statewide percent of vehicles exceeding 55 m.p.h. The VMT by functional system was reported in conjunction with several national studies. It can also be developed from data currently reported by highway functional classification under the Mileage Facilities Reporting System and as part of the Highway Performance Monitoring System. A third source of travel estimates by functional system is the data used by States to prepare the TA–1 table for FHWA.[1] Development of travel estimates by the highway functional classification groupings used in the speed monitoring program becomes basically a process of addition. Determining what proportion of VMT occurs on paved highways subject to the 55 m.p.h. speed limit by highway functional grouping becomes the next step. Building on the data base established for determining the mileage of highways with a 55 m.p.h. speed limit is one possible approach to estimate such travel. In States with relatively even distributions of VMT, an approximation of the proportion of travel within each of the functional groupings of highways with 55 m.p.h. speed limits may be derived by assuming that the VMT on 55 m.p.h. facilities is proportional to the mileage on 55 m.p.h. facilities. Therefore, the proportion of miles of highway with 55 m.p.h. speed limits within the functional grouping could be used as a basis for estimating the VMT within each functional grouping occurring on 55 m.p.h. speed limit roadways.

The next step is to estimate the statewide proportion of VMT on facilities with a 55 m.p.h. speed limit for each of the six highway classification groupings. The proportion of VMT for an individual classification grouping is computed by obtaining the VMT of all the roads with a 55 m.p.h. speed limit in that grouping and dividing this figure by the total VMT of all roads with a 55 m.p.h. limit in the State.

Table II–1 contains an estimate by State of the proportion of VMT on 55 m.p.h. speed limit highways by functional class. These data were extracted from the sample section data submitted by the States to FHWA as part of NHIPS study. The data do not reflect any changes in speed limits and travel distribution occurring since 1975.

Location of HPMS Sample Sections

The location of the HPMS sample sections will be used in the placement of speed monitoring locations. These locations will be used to coordinate data collection efforts of the Federal Highway Administration which will result in future economy in data collection effort due to multi-purpose data collection sites for both State and FHWA studies.

Table II–2 summarizes the prerequisite data that will be needed to develop the Statewide speed monitoring sampling plan.

BILLING CODE 4910-22-M

[1] Travel and Accident Reporting Form 1.

Table II-1

Estimated Proportaion of VMT By Functional Grouping
for Highways with a 55 M.P.H. Speed Limit 1/

State	URBAN			RURAL		
	Interstate	Other Freeway & Expressways	Other Principal Arterials and Minor Arterials	Interstate	Other Principal Arterials and Minor Arterials	Major Collectors
ALABAMA	.076	.010	.045	.145	.457	.267
ALASKA	-	-	-	-	-	-
ARIZONA	.127	.003	.004	.394	.314	.158
ARKANSAS	.084	.018	.002	.205	.449	.242
CALIFORNIA	.302	.289	.035	.106	.188	.080
COLORADO	.146	.055	.013	.265	.391	.130
CONNECTICUT	.548	.213	.0	.141	.098	-
DELAWARE	.303	-	.047	.081	.569	-
FLORIDA	.172	.063	.101	.128	.452	.084
GEORGIA	.176	.024	.008	.237	.348	.207
HAWAII	.786	.014	-	.021	.156	.023
IDAHO	.047	.000	.005	.322	.374	.252
ILLINOIS	.282	.040	.035	.170	.303	.170
INDIANA	.167	.024	.027	.256	.391	.135
IOWA	.051	-	-	.218	.548	.183
KANSAS	.084	.015	.003	.188	.528	.182
KENTUCKY	-	-	-	-	-	-
LOUISIANA	.125	.002	.030	.163	.363	.317
MAINE	.075	.038	.002	.699	.186	-
MARYLAND	.508	.122	.068	.240	.061	.001
MASSACHUSETTS	-	-	-	-	-	-
MICHIGAN	.145	.055	.235	.110	.263	.192
MINNESOTA	.215	.062	.027	.144	.403	.149
MISSISSIPPI	-	-	-	.185	.565	.250
MISSOURI	.193	.092	.006	.200	.332	.177
MONTANA	.016	-	.001	.321	.557	.105
NEBRASKA	.069	-	.007	.245	.610	.069
NEVADA	.085	.036	.019	.386	.380	.094
NEW HAMPSHIRE	.147	.072	-	.341	.412	.028
NEW JERSEY	.286	.295	.135	.049	.207	.028
NEW MEXICO	.107	-	.030	.364	.409	.090
NEW YORK	-	-	-	-	-	-
NORTH CAROLINA	.059	.052	.026	.150	.325	.388
NORTH DAKOTA	.030	-	.008	.221	.600	.141
OHIO	.299	.068	.013	.184	.206	.230
OKLAHOMA	.129	.036	.006	.170	.410	.249
OREGON	.132	.031	.005	.252	.424	.156
PENNSYLVANIA	.111	.083	.046	.231	.399	.130
RHODE ISLAND	-	-	-	-	-	-
SOUTH CAROLINA	-	-	-	-	-	-
SOUTH DAKOTA	.019	-	.005	.299	.540	.137
TENNESSEE	.185	.059	.038	.275	.389	.054
TEXAS	.228	.134	.044	.160	.259	.175
UTAH	.300	.010	.025	.345	.264	.056
VERMONT	.042	.002	-	.843	.113	-
VIRGINIA	.139	.054	.033	.196	.385	.193
WASHINGTON	.304	.064	.008	.177	.318	.129
WEST VIRGINIA	.067	.011	.010	.177	.390	.345
WISCONSIN	.100	.071	.004	.152	.483	.190
WYOMING	.029	.001	-	.459	.446	.065
DIST. OF COL.	-	-	-	1.000	-	-
PUERTO RICO	-	.556	-	-	.444	-

1/ These factors calculated from 1975 mileage, ADT, and speed limit data submitted for the HPMS.

Table II-2

Sampling Plan Prerequisite Data

Functional Grouping / Prerequisite Data	Miles of Roadway	Miles of Roadway with 55 M.P.H. Limits	Total DVMT	DVMT on Roadways with 55 M.P.H. Limits	Proportion of Statewide DVMT on Highways with 55 M.P.H. Limits[1/]
URBAN					
Interstate					
Other Freeways and Expressways and					
Other Principal Arterials and Minor Arterial Street Systems					
Urban Total					
RURAL					
Interstate					
Other Principal Arterials and Minor Arterial Road System					
Major Collectors					
Rural Total					
Statewide Total					

1/ Proportion of statewide DVMT on highways with a 55 m.p.h. speed limit calculated as the DVMT on facilities in that functional group with a 55 m.p.h. speed limit divided by the statewide total DVMT on highways with a 55 m.p.h. speed limit.

BILLING CODE 4910-22-C

III. Sampling Guidelines

This chapter presents a sampling plan which has been designed to monitor the speeds of all vehicles traveling on paved arterial and collector roads with a 55 m.p.h. speed limit. Particular attention is given to statistical validity and to the applicability of the monitoring system to States of widely varying sizes and geographical characteristics.

The process of sampling design may be conveniently divided into the following steps:

- Overview of sampling plan;
- Statistical criteria for sample design;
- Length of monitoring period for individual sampling sessions; [2]
- Minimum numbers of statewide sampling locations;
- Allocation of sampling locations by highway functional groupings;
- Selection of highway sample segments; and
- Development of annual sampling plans.

Each one of these steps is discussed in detail and examples are provided where appropriate.

Overview of Sampling Plan

The sampling plan developed to meet the required objectives of the speed monitoring program is in principle very similar to the one introduced in the "Procedural Guide for Speed Monitoring" published in September of 1975. It consists of a two-stage sample. The first stage is a stratified sample from the population of highway segment in each State. The total number of segments to be sampled in each State is based on the variance of the percentage of vehicles exceeding 55 m.p.h. among locations within the State. The number of segments to be sampled in each stratum (highway functional grouping) is based on the relative vehicle miles of travel (VMT or DVMT) on roads subject to a 55 m.p.h. speed limit. The second stage is a sample of vehicles passing the specific locations.

A major revision from the earlier speed monitoring program consists of a new highway grouping scheme described in Chapter II, which has been introduced because of the need for standardized highway data collection programs. The new scheme will also simplify the process of obtaining the VMT estimates necessary for the sample allocation and later for the development of statewide percentage estimates.

The approach employed in previous speed monitoring programs has been to obtain the same level of accuracy for each of the several highway systems or groupings. Because of the requirements included in the 1978 legislation, the new approach will allow the accuracy to vary in the different functional groupings as long as the target accuracy of the statewide percentage exceeding 55 m.p.h. attains the required level.

Even though the percentage of all vehicles exceeding 55 m.p.h. is the characteristic on which the certification will be based, this percentage is by itself not sufficient to quantify the actual distribution of speeds. As an example of how data beyond the percentage can be useful to a State in analyzing speed patterns, two possible situations are analyzed. In the first situation, 75 percent of the travel is exceeding 55 m.p.h. and the mean speed is 56 m.p.h. In the second, 60 percent is exceeding 55 m.p.h. and the mean speed is 62 m.p.h. The mean speeds indicate that in the first case increased enforcement will probably not significantly affect the result, while in the second case increased enforcement could have a significant effect.

A conflict arises when trying to attain the objectives of a highly reliable estimate of the percentage exceeding 55 m.p.h. which requires a very large amount of data, while also trying to obtain other relevant statistics needed to quantify the speed population which do not require high reliability levels. A compromise solution consisting of two different levels of data collection has been devised to attain these two different objectives. The sampling plan will consist of a statewide number of sampling locations which will be classified into two groups: *standard sampling locations* and *control sampling locations.*

Standard Sampling Locations.—A standard sampling location is by definition a location where a minimum of one standard sampling session is required per year. A standard sampling session consists of a monitoring period at least 24 hours in length where only two data items are required, the number of vehicles exceeding 55 m.p.h. and the total number of vehicles passing the location during the monitoring period.

Control Sampling Locations.—Control sampling locations will be sampled once each quarter in order to measure seasonal variation, to collect additional speed data, and to provide a basis for trend determination. At least 33⅓ percent of the number of locations in each highway grouping should be sampled as control locations, with a minimum of two in each applicable highway grouping.[3] Data collected at control sessions will consist of the individual speeds of all vehicles passing the location during the monitoring period, or alternatively the speeds classified in small ranges (5 miles per hour). Data from control sessions will be used to estimate the percentage exceeding 55 m.p.h. and also to provide the data to estimate the mean speed, median speed, percentage exceeding 60 m.p.h., percentage exceeding 65 m.p.h., 85th percentile speed, etc.

The advantage of this double approach involving different levels of data collection is that it concentrates the data collection on the required characteristic while minimizing the level of effort and the need for expensive equipment.

Statistical Criteria for Sample Design

The following criteria are established as the minimum basic requirements of the sample design:

1. The target precision of the statewide percentage exceeding 55 m.p.h. must be sufficient to significantly detect an absolute difference greater than 2.0 percent.

2. A significance level of 5 percent shall be used for all estimates.[4]

3. Statistical estimates of the percentage exceeding 55 m.p.h. derived from data collected as part of this program will meet the requirements of criteria 1 and 2 on an annual basis.

Criteria 1 and 2 imply that based on the sample design the data collected should be sufficient to estimate a 95 percent one-sided confidence interval with an absolute value of 2.0. Assuming that the target precision is achieved, this means that a percentage exceeding 55 m.p.h. greater than 72.0 will be judged significantly larger than 70 percent.

Criterion 3 states that only after a full year's data are collected will the estimates be expected to attain the required precision. However, because of the procedure by which data will be collected, it will be possible to obtain quarterly estimates which, of course, will have a much lower precision. Assuming that one-fourth of the annual sample is taken each quarter, the quarterly estimates of the percentage exceeding 55 m.p.h. will have an approximate 5.0 absolute precision.

---

[2] Distinction is made between *sampling sessions* and *sampling locations.* A session consists of a single period of monitoring at a particular place (sampling location). For the purposes of this study, up to four sampling sessions may be conducted at one sampling location.

[3] This rule represents an administrative decision and is based on providing sufficient sessions to estimate the remaining characteristics of interest and seasonal differences.

[4] A significance level of 5 percent is equivalent to a 95 percent confidence interval.

Length of Monitoring Period for Individual Sampling Sessions

Estimating the percentage of vehicles exceeding 55 m.p.h. with the target precision at a 95 percent confidence is the only constraint in the sample size estimation process. The speeds of vehicles passing each location constitute the subpopulation to be sampled. A cluster of these speeds is collected to estimate the percentage exceeding 55 m.p.h. at that particular location. In order to estimate the speeds of vehicles passing each location during the year, it would be necessary to obtain a complete cluster consisting of the speeds of all vehicles passing the location during the entire year. Because of the enormity of the size of each cluster and the cost involved, it becomes necessary to select a shorter period of time and to assume that measuring the random sample locations consistently throughout the year will balance out the effects of periodic variation. This is why it becomes so important to distribute the sampling in the manner presented in Chapter IV.

A *24-hour monitoring period* has been selected for the following reasons:

- Accounts for the varying traffic conditions affecting speeds;
- The within-cluster variation will not allow a reduction of the number of locations required even if much longer periods are used;
- Minimizes cost in terms of the combination of sampling locations required and the need for equipment;
- Facilitates scheduling of data collection; and
- Allows aggregation of estimates by day of week, month, etc.

The fact that the number of vehicles sampled during the 24 hour monitoring period will vary greatly among sessions is to be expected and will be accounted for in the estimation process presented in Chapter V.

Minimum Number of Statewide Sampling Locations

Two concepts will be used in determining the statewide location sample size. The two are *reliability of statistical estimates* and *coverage of population sampled.* The standard statistical requirements for determining statewide sample size, based on the reliability approach presented here, are dependent primarily on the statewide standard deviation of the parameter (percentage exceeding 55 m.p.h.) rather than on mileage or vehicle miles of travel. Since preliminary studies indicate this figure to be similar in most States, the resultant sample sizes will also be nearly the same with the exception of very small States where the finite population correction will exert more influence. This means that statistically the sizes of the speed populations of different States influence very little the sample sizes required for estimation. Having nearly equal samples for the different States would seem not to provide data that are representative of the widely varying travel characteristics found among the States.

The concept of "coverage of population sampled" was introduced to answer the above concern, to provide a balanced work load among the States, and to provide a safety margin of increased accuracy for the larger States with larger mileage and VMT.

In order to incorporate these two concepts into the sampling plan, it was decided to determine the minimum sample size needed by each State under each of the two concepts and then to select the larger of the two numbers as the statewide minimum sample size. In this manner the reliability requirement will always be met and the sample size will be sensitive to the varying amounts of travel in the States.

Minimum Sample Size Based on Reliability Requirement

The sampling scheme consists of two stages of sampling. The first stage consists of a statewide sample of locations selected randomly from the stratified population of highway segments with a 55 m.p.h. speed limit. The statewide number of sampling locations is distributed by highway functional grouping on the basis of relative travel (VMT or DVMT). In the second stage, a 24-hour cluster sample is collected from the subpopulation of speeds of vehicles passing each location during the year.

To determine the number of locations required to obtain the desired precision, a preliminary estimate of the standard deviation of the parameter (percentage of vehicles exceeding 55 m.p.h.) must be computed. This is an important step since the standard deviation greatly affects the sample size. Underestimating the standard deviation will result in estimates that will not meet the specified precision requirement. The formula which must be used to compute this estimate corresponds to the sample design (stratified cluster sample), and is also presented in Chapter V.

For the initial year, two alternatives exist: (1) calculate the estimate subject to several predetermined conditions; and (2) use the default value provided in this manual.

The conditions that must be met to compute standard deviation estimates of the percentage exceeding 55 m.p.h. from existing data are as follows:

1. Sufficient sample of locations (minimum of 20).
2. The speed data must represent all vehicles.
3. Monitoring periods of at least 24-hour duration.
4. The monitoring locations must be distributed throughout the State (minimum of 2 per functional grouping) and throughout a full year.
5. The monitoring locations must have been randomly selected.

These conditions are needed to insure that the target reliability is approached. The first four conditions apply for obvious reasons. The last, random selection, is of particular importance because it allows the variability to show. If the present locations were selected subjectively to match certain characteristics, the results will be similar and the variability of the system will be underestimated. This is why, theoretically, the reliability of any estimate is invalidated by subjective selection. For subsequent years, the sample size estimation procedures in Chapter V must be used.

The default value for the standard deviation of the percentage of vehicles exceeding 55 m.p.h. is 7.0. This value was arrived at by analyzing data from several States. However, none of the States had sufficient individual data to meet the above requirements needed to develop a reliable statewide estimate. Due to the general lack of appropriate data, we recommend that all States use the default value for the first year's study design.

BILLING 4910-22-M

The formulas to estimate the required statewide number of locations are:

$$n_o = \left[\frac{z_{.95} \quad s(P_{st})}{d}\right]^2$$

and

$$n_p = \frac{n_o}{1 + n_o / N}$$

where

n_o = sample size before finite population correction;

$z_{.95}$ = value of the normal distribution based on a one-sided 95 percent confidence interval

= 1.645;

$s(P_{st})$ = standard deviation fo the percentage of vehicles exceeding 55 m.p.h.

d = precision level required (2.0);

n_p = statewide sample size; and

N = total number of 5-mile segments subject to the 55 m.p.h. limit in the State (see section describing frame construction).

The second equation introduces reductions in sample size for small States, and in statistical terminology is usually defined as the finite population correction.

BILLING CODE 4910-22-C

Example III-1

Let's examine the initial (first year) sample size estimating procedure using the default value (7.0) and two other estimates of the standard deviation. Assume a State with 1,500 segments (frame size = 1,500).

$$n_o = \left[\frac{1.645 \quad (7.0)}{2.0}\right]^2 = 34$$

$$n_p = 34/(1 + 34/1500) = 34$$

Using a lower value (5.0),

$$n_o = \left[\frac{1.645 \quad (5.0)}{2.0}\right]^2 = 17$$

$$n_p = 30/(1 = 30/1500) = 17$$

Using a higher value (9.0),

$$n_o = \left[\frac{1.645 \quad (9.0)}{2.0}\right]^2 = 55$$

$$n_p = 55/(1 + 55/1500) = 54$$

This example illustrates the difficulty of the process, i.e., good estimates of the standard deviation may not be available, yet this parameter could nearly halve or double the sample size needed to meet the target precision.

Minimum Sample Size Based on Coverage of Population Sampled.—The coverage concept is designed to allocate locations based on the amount of travel (DVMT) subject to the 55 m.p.h. speed limit in the States. This concept is needed to provide a balanced sample size; to compensate for the additional variation which may be present due to larger volume or larger mileage; and for the potential variation in speed enforcement activities of different police departments, districts, or jurisdictions within a State. As an example, if two States with respectively 1,000 and 10,000 miles of highway subject to the 55 m.p.h. speed limit were sampled using 100 locations, then the first State would have one location for each 10 miles of highway while the second would have one for each 100 miles. The coverage of the first State would be 10 times that of the second. Even though the initial statistical model used for both States should result in similar precision of the estimates, the potential for variation is much larger in the second State. The method presented here attempts to compensate for this fact. In addition, the coverage concept provides an additional safety margin for the use of the default standard deviations and for the effects of clustering on sample size.

The minimum sample size needed under the concept of coverage shall be computed by dividing the statewide total daily vehicle miles of travel (DVMT) subject to the 55 m.p.h. speed limit by 2,000,000. For example, the minimum sample size under this concept for a State with 40 million DVMT on highways subject to the 55 m.p.h. limit would be 20 locations. The divisor (2,000,000) in the procedure represents an administrative decision to ensure that speed data represent the wide range of travel, topography, geometrics, enforcement, etc., present in the various States. The next example illustrates the statewide sample size selection procedure for a hypothetical State.

Example III–2

Determine the number of monitoring locations required by a State with 80 million DVMT on roads subject to the 55 m.p.h. limit and with a frame size of 1,500 segments. From Example III–1, the number of locations under the reliability requirement is 34 locations. Under the coverage concept the number is 40 (80,000,000/2,000,000). The larger of the two is 40, and this then becomes the statewide minimum sample size.

Allocation of Sampling Locations by Highway Functional Grouping

Having determined the statewide number of locations needed, we proceed to allocate them by highway grouping. To do this, it is necessary to estimate the relative travel (VMT or DVMT) carried by the segments with a 55 m.p.h. speed limit in each functional grouping (See chapter II).

The following formula is then used to accomplish the allocation:

$n_h = n_p W_h$

where n_h = number of locations allocated to the h^{th} functional highway grouping;
n_p = statewide minimum sample size (number of monitoring locations); and
W_h = relative travel (VMT or DVMT) on roads subject to the 55 m.p.h. speed limit in the h^{th} highway grouping (See Chapter II).

This formula proportions the sample size on the basis of relative travel. States with most of their travel on highways subject to the 55 m.p.h. speed limit in one or two highway groupings will find that this method will concentrate the sampling on those groupings. If there is no travel subject to the 55 m.p.h. speed limit in a particular highway grouping, no sessions will be allocated to that grouping by this procedure.

In order to further simplify the procedures, no locations need to be allocated to any functional grouping with less than one percent of the statewide travel subject to the 55 m.p.h. speed limit (W_h of 0.01 or less) and any such groupings may be completely disregarded from the speed monitoring program. In these cases, the weights of the remaining highway groupings must be factored to represent the total statewide travel.

Example III–3

Allocate a minimum statewide sample size of 40 locations based on the following characteristics:

Highway grouping (h)	Relative VMT on roads subject to 55 m.p.h. speed limit (W_h)
1	0.11
2	.23
3	.31
4	.07
5	.19
6	.09

Using the formula for h=1, n_1=40 (.11)=4, the results are summarized below:

Highway grouping	Sample size (n_h)
1	4
2	9
3	12
4	3
5	8
6	4
Total	40

Selection of Highway Sample Segments

The final step in the sample design involves the selection of locations where the sampling sessions will take place. The process can be subdivided into two steps:

1. Construction of sampling frames.
2. Selection of sample segments.

Construction of the Sampling Frames.—A sampling frame consists of a listing of every individual item in the population to be sampled so that a probability assignment can be made. The ideal way of sampling the population of speeds would be to construct a frame consisting of the speeds of vehicles traveling on each highway system during the year, and then to take a simple random sample of speeds. This is, of course, impossible. Therefore, other more practical alternatives such as cluster sampling have to be used.

To construct a frame of highway segments, it is necessary to identify the mileage of every highway with a 55 m.p.h. speed limit in each highway functional grouping (See Chapter II). Then subdivide the mileage into 5-mile segments[5] and assign a unique sequential number to each segment. Individual segments need not be identified at this stage; only a sequential numerical assignment is needed. One such frame should be constructed for each of the functional groupings. The statewide frame size is the total number of 5-mile segments in the State which are subject to the 55 m.p.h. speed limit.

Selection of Sample Segments.—In order to meet the two-fold requirements of estimating with the specified accuracy the percentage exceeding 55 m.p.h. and of collecting other important statistics without a reliability constraint, the statewide number of sample locations is divided into standard and control locations. As previously defined, a standard sampling location (and session) requires only the collection of the number of vehicles exceeding 55 m.p.h. and the total number of vehicles passing the location during a 24-hour period. The location of these sessions

[5] The determination to use 5-mile segments was a compromise between statistical validity and practical considerations. Statistically, the smaller the segments the more confidence we have in the assumption that conditions affecting speeds in the segment are constant. However, to be of practical use the frame must be of manageable size.

must be established by a simple random selection without replacement with the help of a table of random numbers. It is imperative that random selection be used because all formulas presented assume a random selection.

Control sampling locations (and sessions) serve three purposes: to collect 24-hour counts of vehicles exceeding 55 m.p.h. and total number of vehicles, as for a standard session; to collect the individual or groups of speeds of all vehicles passing the location during the 24-hour period to provide other necessary statistics; and to provide an estimate of seasonal variation of speed statistics. Control locations should constitute at least *33⅓ percent* of the number of locations in each highway grouping. A minimum of two control locations must be monitored in each applicable highway grouping. Control locations are also to be selected randomly from the frame.

It is required that all 55 m.p.h. speed monitoring control locations be placed on HPMS sections. This will result in future economy in data collection efforts due to multi-purpose data collection for both State and FHWA studies. Once the randomly selected location for each control station is known, these locations can be moved to HPMS sections in two ways. First, control locations should be moved to the nearest HPMS sample section that meets the criteria listed below. An HPMS section should replace a randomly selected control location on a one-for-one base if it meets the following conditions:

(A) The HPMS sample section and the random control location it is replacing must have the same;

- Speed limit (55 m.p.h.),
- Functional grouping,
- Geographical area, and
- Preferably the same continuous highway.

(B) Both locations must be similar in terms of geometrics and traffic characteristics. These judgments will be largely subjective, but both sites should have the same number of lanes, the same topographic features, similar traffic volume and traffic served. In addition, they should not be separated by large traffic generators or major interchanges.

Secondly, if the randomly selected control location is not located within a reasonable distance of an HPMS sample section that meets the criteria stated above, the control location shall become a new HPMS sample section.[6]

[6] Updating procedures contained in: *U.S. Department of Transportation Highway Performance Monitoring System, Field Manual for the Continuing Analytical and Statistical/Data Base,* Federal Highway Administration, 1980.

The manner and sequence in which the locations, both standard and control, are selected should be documented and retained for future review. It will also be very helpful to plot the locations on a map while the selection process is taking place. This will permit visual inspection of the resulting geographic distribution. In general, because of the size of the frame, the locations will be geographically distributed throughout the State. However, geographical stratification may also be introduced by selecting the locations from geographical subsets of the frame or by any other method that does not affect the randomness of the sample. The analysis presented in Chapter V ignores the effcts of the geographical stratification, but the procedures in that chapter can be easily modified to produce estimates by geographical region.

For smaller States with limited mileage, it is probable that locations will be in close proximity. These locations whether standard or control should be sampled at different times during the year based on a random or systematic schedule as shown in Chapter IV.

Example III–4

Construct a frame for the Interstate-rural portion of a State with 160 miles of Interstate with 55 m.p.h. limits.

The frame mapping the actual segments onto a sequential distribution is presented in the following table.

BILLING CODE 4910-22-M

Route	Segment Mileage	Segment	Sequence Numbers
I-95	1-5	1	1
	6-10	2	2
	11-15	3	3
	16-20	4	4
	21-25	5	5
	26-30	6	6
	31-35	7	7
	36-40	8	8
	41-45	9	9
	46-50	10	10
I-25	1-5	1	11
	6-10	2	12
	11-15	3	13
	16-20	4	14
	21-25	5	15
	26-30	6	16
	31-35	7	17
	36-40	8	18
	41-45	9	19
	46-50	10	20
	51-55	11	21
	56-60	12	22
	61-65	13	23
	66-70	14	24
I-44	1-5	1	25
	6-10	2	26
	11-15	3	27
	16-20	4	28
	21-25	5	29
	26-30	6	30
	31-35	7	31
	36-40	8	32

A shorter summary is,

Route	Total Mileage	Number of Segments	Sequential Number of Segments
I-95	50	10	1 to 10
I-25	70	14	11 to 24
I-44	40	8	25 to 32

Assume that the sample size needed for this grouping is 7 locations. Seven numbers between 1 and 32 were selected by using a table of random numbers. The selected segments are listed below.

Random Number	Route	Segment
29	I-44	5
5	I-95	5
9	I-95	9
23	I-25	13
20	I-25	10
17	I-25	7
12	I-25	2

BILLING CODE 4910-22-C

The method of selection for this example specifies that the first 3 selections are the control locations (33⅓ percent). Therefore, four control sessions (one each quarter) will be conducted on sections I–44 segment 5, I–95 segment 5, and I–95 segment 9; while one yearly session will be conducted in each of the four selected standard locations.

This is by far an oversimplified example, but it presents the approach which should be followed. Further quidelines as to the location and scheduling of sessions are presented in later chapters.

The selection of 24–hour clusters of speeds also assumes that the date selected in random. However, for the sake of simplicity, practicality, and to allow for an orderly schedule, it has been assumed that the scheduling procedures presented in Chapter IV will satisfy this requirement.

Development of Annual Sampling Plans

The procedures presented in this chapter have purposely been designed to attain the required objectives in the face of many unknowns. This has necessitated many assumptions for the development of the initial plans. Major emphasis has been placed on maintaining approaches which are consistent among States, and which provide a basis for equitable decisions. After a complete year's data are available, and thereafter on an annual basis, an evaluation must be made to determine the actual precision level obtained. Based on this evaluation, changes should be made to the sampling plan to increase its overall efficiency or to attain the required reliability. In particular, the statewide standard deviation estimate derived by the procedures in Chapter VI should be used to recompute the necessary sample size under the accuracy concept. If it becomes necessary to increase the sample size, new locations can be randomly selected by the methods described in this chapter. In the same manner, a decrease in sample size may permit a random selection of locations where monitoring will stop. In any case, the locations selected during the intitial plans may be considered permanent locations. Additions or deletions necessitated by increases or decreases in sample size, by speed limit changes, by highway grouping changes, or by other reasons will not affect the location of any sessions selected during the implementation of the intial plan. Annual evaluations should also include an examination of the travel figures (VMT or DVMT) to ascertain their validity and to make updates as needed.

IV. Data Collection

This chapter summarizes data collection procedures that could be used during the speed monitoring program. It is intended to be a brief outline of basic procedures that should be expanded on by each State in developing its speed monitoring program.

Organization

The program manager or his representative should be responsible for obtaining all speed measurement equipment, other support equipment and personnel. In addition, a detailed schedule should be developed that includes:

- Date/time of equipment setup at each location;
- Date/time of equipment takedown at each location;
- Travel time; and
- Makeup time for equipment malfunction; bad weather, etc.

This schedule should be as comprehensive as possible so that each member of the data collection team knows what work is expected of him. This schedule should be shown to district or local engineers so that data collection does not occur during construction/maintenance activities that might interfere with normal vehicle speeds.

Scheduling the Data Collection

Data collection scheduling should be developed to account for the hour of the day, day of the week, month, and season of the year. To account for the hour of the day and the day of the week, all data collection sessions should be 24 hours long and evenly distributed by day of the week. At the control locations one session of data will be obtained each *quarter*. At standard locations one session of data will be obtained each *year*. Table IV–1 is an example of how to schedule data collection at 40 locations. First, the total number of control locations must be determined (see example III–4, page III–12 for determining the total number of control locations). Divide the standard sessions into four equal parts. These four parts represent monitoring effort at standard locations for the four quarters of the year. Within each quarter, all sessions whether standard or control should be evenly distributed by day of week. In this example 24 standard locations (24 standard sessions) and 16 control locations (64 control sessions) must be evenly distributed throughout the year.

The resulting data collection schedule in Table IV–1 provides for six standard and 16 control sessions every quarter. The monitoring sessions are further distributed by day of the week. No specific days of the month are selected, therefore leeway is provided for bad weather, equipment malfunctions, etc.

As an option, to evenly distributing standard sessions among the four quarters, States having disproportionate quarterly VMT figures (northern States during the winter quarter) may wish to allocate the standard monitoring sessions on the basis of estimated quarterly VMT. In any case, control locations must be monitored once each quarter in order to derive quarterly estimates.

BILLING CODE 4910-22-M

Table IV-1

Example Schedule for Data Collection During Fiscal Year

Number of Sessions

	FIRST QUARTER		SECOND QUARTER		THIRD QUARTER		FOURTH QUARTER	
	Standard Sessions	Control Sessions	Standard Sessions	Control Sessions	Standard Sessions	Control Sessions	Standard Sessions	Control Sessions
MON	1	3	1	2	1	2	1	3
TUE	1	3	1	2	1	2	1	2
WED	1	2	1	3	1	2	1	2
THUR	1	2	1	3	1	2		2
FRI	1	2	1	2		3	1	2
SAT	1	2		2	1	3	1	2
SUN		2	1	2	1	2	1	3
TOTAL	6	16	6	16	6	16	6	16

Total Number of 88 Sessions

BILLING CODE 4910-22-C

Field Data Collection

Review Highway Conditions.—When the field personnel arrive at the designated highway segment (5 miles long), they should visually determine the suitability of conditions at the site. Speed monitoring should not be attempted under the following conditions:

- Extreme weather conditions expected during the next 24-hour period (severe rainstorms, heavy snow accumulating or icy roadway);
- Presence of non-routine enforcement activity within the highway section in the next 24 hours; or
- Construction/maintenance activity or other disruptive activities which affect the speed of vehicles passing the site.

If any of these conditions appear to exist within the designated highway section, the field personnel should immediately contact the program manager or his representative so that the session can be rescheduled.

Location of Monitoring Station.—Once the highway section is located, the field crew should drive the section to become familiar with its characteristics and to spot any unusual conditions. A second drive along the section should be made to select the location for the speed monitoring equipment if not permanent. If this location is to be a permanent station, the program manager or his representative may want to select the location of the speed monitoring equipment before it is scheduled so that a loop detector or some other type of permanent sensor can be placed in the pavement. Since stations can be monitored over a long period of years, this may be a cost-effective measure.

Once the location of the speed monitoring station has been decided, the field crew should review the location to avoid any features that could be expected to encourage or discourage vehicle speeds. The location of the speed monitoring station should be representative of typical conditions on the section. Situations to be avoided are:

- Near or on a sharp horizontal curve with a speed advisory plate less than 55 m.p.h. (i.e., greater than 5° curve);
- Steep grades (i.e., greater than 4 percent) not representative of predominant alignment (if predominant alignment is greater than 4 percent, a representative sample of vehicle speeds in both directions of travel should be obtained.);
- Near significant roadway intersection (i.e., less than 1,000 feet) or commercial entrances (e.g., shopping center ingress and egress points); or
- Where other unusual features exist that might influence the speed (e.g., narrow bridge).

It is also extremely important that the monitoring station location match all of the additional location criteria developed by the program manager. The criteria established should be carefully followed in locating all speed monitoring stations since failure to follow these guidelines will result in speed data that are not directly comparable.

Speed Monitoring Systems.—The Federal Highway Administration has conducted tests on all existing speed monitoring systems. These systems were limited to equipment commercially available as of November 1979 and which could use either D.C. power or have a D.C. power option. The goal of these tests was to determine the accuracy and reliability of existing speed monitoring equipment and speed detectors. The results of these tests are summarized in the report, *Evaluation of Speed Monitoring Systems,* Federal Highway Administration, Office of Highway Planning, July 1980. This report is available from any Federal Highway Administration office.

Procedures for Obtaining and Recording Data.—The minimum speed data to be obtained at each site shall include a count of all vehicles and of those exceeding 55 m.p.h. in one randomly selected direction of travel. This will enable the calculation of the percent of vehicles exceeding 55 m.p.h. during a 24-hour data collection session. The additional requirement to measure the speed of all vehicles passing the speed monitoring station during the observation period will affect the decision on the type of equipment to be used. The data collection procedure will first be reviewed for the recording equipment then for nonrecording equipment (radar).

1. *Recording Equipment*-Since recording equipment varies considerably depending on the manufacturer and model, only general guidelines can be suggested here.

Two common types of detectors are available to be placed on the roadways for speed monitoring. The first is the standard loop detector. Loop detectors are permanently placed in the pavement. The second type includes temporary sensors (e.g., tape switch, cable sensors) and pneumatic tubes. These sensors must be placed on the pavement just before the start of each speed monitoring session. Extreme care is needed in placing the cables on the pavement since all traffic in one direction must be stopped from 1 to 3 minutes to place the temporary sensors on the road. The sensors are typically held on the pavement by glue, tape or both. There may be some problems holding the sensors to the pavement during wet or cool weather. Both types of sensors perform well when properly placed on the highway.

Data recorders can be placed at a great distance from the sensors where the recorder can be secured. The deployment of the data recorder with the temporary sensors will take approximately 1 hour. A shorter deployment period would be needed if permanent loop detectors were already in place.

a. *Document Speed Monitoring Station*—The field data collection crew should take care to document the location, equipment setup, and equipment used. The following information should be included in station setup documentation:

- Location of site
- Station number
- Session number
- Equipment used (so malfunctioning equipment can be identified)
- Field data collection crew names
- Time of arrival at site
- Sketch of site indicating

1. Location of speed monitoring equipment (sensor, recorder, etc.)
2. Direction of traffic monitored
3. Geometrics of highway (lane width, shoulder width, etc.)
4. Other physical features

- Calibration of equipment checklist completed (check manufacturer literature)
- Time equipment is turned on

Each manufacturer's recommended calibration procedures should be completed before the monitoring session begins. Any discrepancy should be reported to the program manager or his representative. No measurement should be taken with inaccurate equipment.

b. *End of Session Procedures*—When the crew first arrives, they should determine if the equipment is operating and run all calibration tests and then record the data, if appropriate, on the data collection form. The crew should review the data collected to see if it is reasonable. The speed monitoring equipment should be removed from the road and stored. All forms should be reviewed for completeness, assembled and secured in a single envelope to prevent loss and forwarded to the program manager or his representative.

2. *Nonrecording Equipment*—Nonrecording equipment is the type of equipment used by most law enforcement agencies and consists of various forms of radar, VASCAR, etc. It will be assumed for this discussion that

radar is the most common form of nonrecording equipment.

The radar equipment should be set up and operated in accordance with the manufacturer's instructions, using the procedure discussed in the training sessions. Since the capabilities of radar units vary considerably (e.g., the maximum operating range of some units is 500 feet while others are still accurate at 1,500 feet) depending on the manufacturer and model, only general guidelines can be suggested.

Several types of station layouts are presented in Figures IV–1 through IV–4. When suitable cover is available (e.g., bridge supports or roadside foliage), method A may be the most appropriate configuration. Under heavy traffic conditions, however, the accurate measurement of vehicles may become complicated.

Method B may be used for situations where sufficient cover for effective concealment is not available. Since the equipment is positioned on the opposite side of the road, motorists will be less inclined to react.

Method C is perhaps the most common configuration used for enforcement. This method should not be used unless ample screening is available to hide the crew and measurement equipment. Radar units effectively concealed in mailboxes or other containers can be used. For States in which recreational or highway maintenance vehicles have been shown to not influence drivers' speeds, method C may be used in conjunction with appropriately disguised State vehicles containing the measurement equipment.

Although method D can be effectively applied to any site for which a highway overpass is available, it is most suitable for multilane freeways. It is extremely important, of course, that suitable areas to place the equipment (e.g., sidewalk) and to park the vehicle that powers the radar unit be available to prevent safety hazards to the crew or substantial inconvenience to motorists on the bridge.

The field crew should choose the most appropriate configuration to monitor speeds at each station. At a minimum, the station must have the following characteristics:

- Able to accurately measures speeds of all vehicles in all lanes in the designated direction;
- Concealment such that motorists do not slow down before their speeds are measured (CB radios and radar detectors must not have any effect on speeds of vehicles monitored); and

BILLING CODE 4910-22-M

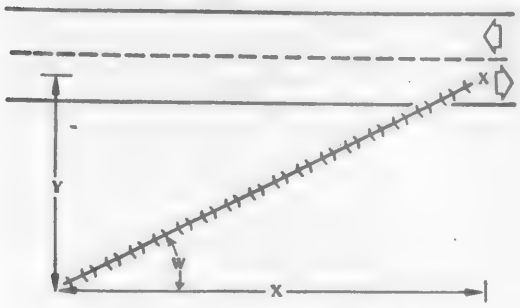

Figure IV-1 Radar Setup - Method A

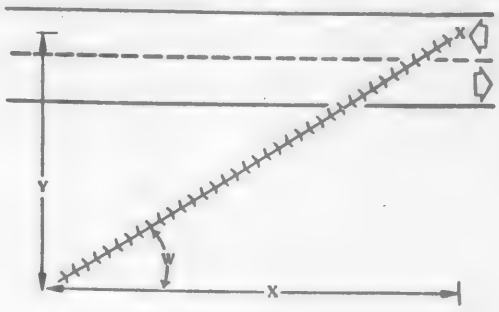

Figure IV-2 Radar Setup - Method B

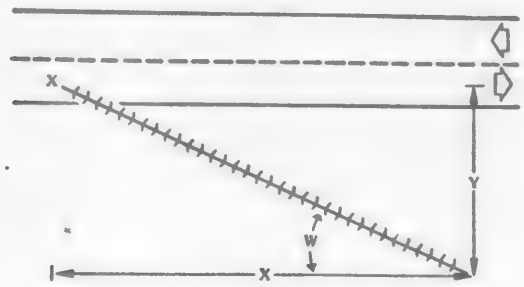

Figure IV-3 Radar Setup - Method C

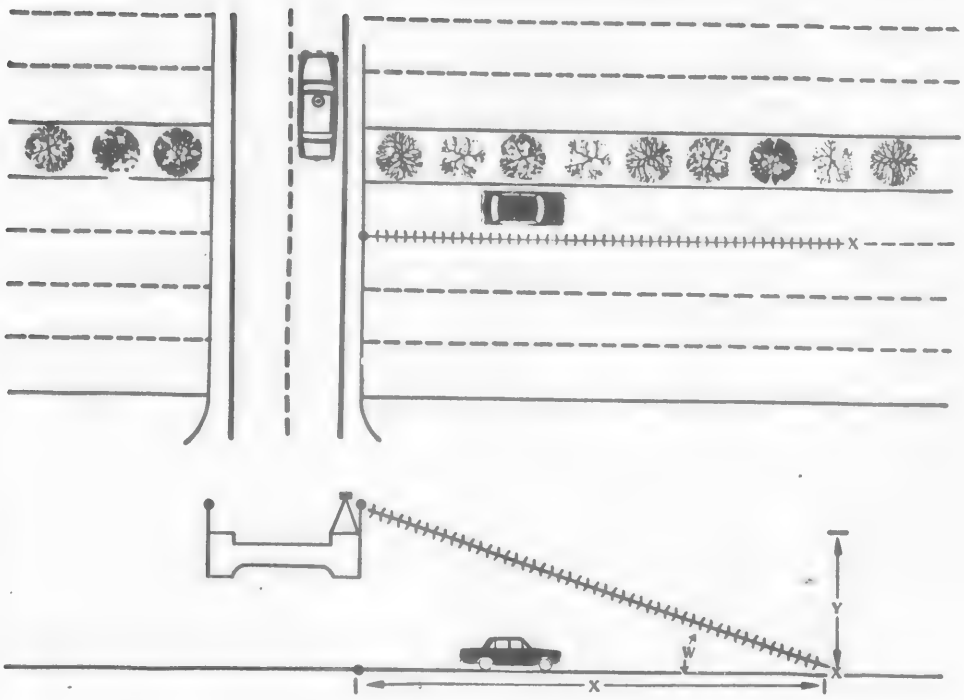

Figure IV-4 Radar Setup - Method D

BILLING CODE 4910-22-C

• Provides safety for the field crew and does not present hazards to motorists.

a. *Documentation*—The final station configuration must be fully described by the field crew at the site. This should include the preparation of a detailed sketch similar to the illustrations in Figures IV–1 through IV–4. It is extremely important that the dimensions "x" and "y" in the figure be measured at the station location and the number of lanes be indicated on the sketch. The methods of concealment should also be shown (e.g., presence of trees and bushes, bridge supports).

It is desirable to take photographs of the location itself, the segment of road being monitored, the equipment setup (including the placement of the vehicle), and the methods of concealment if not obvious from the other pictures. If self-developing cameras are used, each photograph should be carefully labeled at the site, otherwise, detailed notes describing the pictures should be recorded separately.

b. *Beginning of Session Procedures*—The radar manufacturer's recommended calibration tests should be made. Each tuning fork should be struck in the palm of the hand and quickly held in front of the radar transmitter. The precise meter reading resulting from each test should be recorded on the data collection form. Any discrepancy greater than 2 m.p.h. should immediately be reported to the program manager; no measurement should be taken with an inaccurate radar unit.

After the station setup has been described and calibration tests successfully completed, the data recording technician should note the starting time on the data collection form.

c. *Measurement and Recording of Speeds*—The radar operator should then begin measuring vehicle speeds. It is the objective of this program to measure the speed of every vehicle. Care must be taken, however, that the "wrong" vehicle (for example, a vehicle in the opposing direction) is not measured. Speed readings that cannot be identified to a specific vehicle should not be recorded. When the radar operator "catches" the desired vehicle the speed should be spoken to the recording technician, who must carefully enter this information on the data collection form. Several shifts of personnel may be needed during the 24-hour data collection period.

The stopping time should be entered on the data collection form. Additional comments concerning any aspect of the speed measuring activity (e.g., changes in weather) should also be recorded.

d. *End of Session Procedures*—The calibration of the radar unit should again be tested using the same procedures as before. The results of the test should be recorded on the data collection form.

All required information should be noted legibly on the data collection form. Any missing items should, of course, be entered.

V. Data Analysis and Sample Design Evaluation

This chapter describes the procedures to be used in analyzing speed monitoring data. The main objective is to develop standard procedures applicable to all States in order to insure that comparable results are obtained. The chapter is divided into four sections:

• Computation of statistics related to the percentage exceeding 55 m.p.h.

• Sample size determination based on data analysis.

• Computation of other statistics (mean, median, 85th percentile, and percentages exceeding other speeds).

• Specialized analysis.

Each of these sections is designed to present both the formulas and the procedure to be followed. Simplified examples are provided to illustrate the procedures. These examples also present a worksheet approach which can be used to make the actual calculations.

Computation of Statistics Related to the Percentage Exceeding 55 M.P.H.

An estimate of the percentage exceeding 55 m.p.h. and its standard error are derived for each highway grouping and then combined for the Statewide estimates. The Statewide standard deviation can be used to determine the actual statistical reliability obtained and to determine whether the sample size for the next year's design needs adjustment.

The proportion exceeding 55 m.p.h. at each standard location is computed by dividing the number of vehicles traveling at speeds in excess of 55 m.p.h. by the total number of vehicles measured. The percentage of vehicles exceeding 55 m.p.h. is derived simply by multiplying the proportion by 100.

At control locations, four quarterly sessions are obtained and a special procedure is needed to equate them with annual sessions at standard locations. This is done by averaging the number of vehicles exceeding 55 m.p.h. and the total number of vehicles measured during the four control sessions (Example V–1). These averages are then used to compute the annual proportion of vehicles exeeding 55 m.p.h. at that control location and also to represent that location in the highway grouping and Statewide figures.

Example V–1

Compute the average percent of vehicles exceeding 55 m.p.h. at a control location.[7]

[7] To maintain numerical accuracy, keep all figures in the computations to three decimals, but round the final statistic to one decimal.

Location Number 1

Quarter	Number of Vehicles Exceeding 55 m.p.h.	Total Vehicles Measured
1	2377	6731
2	3268	5508
3	3565	7343
4	2674	4895
Total	11,884	24,477
Average	2,971	6,119

$$\text{Average Percent Exceeding 55 m.p.h.} = 100 \times \frac{2971}{6119} = 48.6$$

Percentage Exceeding 55 m.p.h. by Highway Grouping.—The estimated percentage exceeding 55 m.p.h. for each highway grouping is derived by summing the number of vehicles exceeding 55 m.p.h. in all the sample locations within the highway grouping, dividing this sum by the total number of vehicles measured in the highway grouping, and multiplying the results by 100. Control location figures must be averages of the four sessions.

In equation form

$$P_h = p_h \times 100 = \frac{\sum_{i=1}^{n_h} y_{hi}}{\sum_{i=1}^{n_h} x_{hi}} \times 100$$

where—

P_h = percentage exceeding 55 m.p.h. in the h^{th} highway groupong ($h=1, \ldots, 6$).

p_h = proportion exceeding 55 m.p.h. in the h^{th} highway grouping.

n_h = number of locations in the h^{th} highway grouping [8] i ($i=1, \ldots, n_h$) of the h^{th} highway grouping.

Example V–2

Compute the estimated percentage exceeding 55 m.p.h. based on the following data from a highway grouping ($h=1$):

(1) Location Number (i)	(2) Number of Vehicles Exceeding 55 m.p.h. (y_{hi})	(3) Total Vehicles Measured (x_{hi})
1[1/]	2,971	6,119
2	2,069	4,484
3	5,361	7,949
4	12,561	15,412
5	8,631	12,703
6	1,921	4,918
7	2,168	4,682
Total 7	35,682	56,267

The proportion of vehicles is the number of vehicles exceeding 55 m.p.h. divided by the number of vehicles measured,

$P_1 = 35{,}682/56{,}267 = 0.634$

and the estimated percentage is 0.634 times 100 equals 63.4 percent.

Statewide Percentage Exceeding 55 m.p.h.—Once estimates have been computed for each of the applicable highway groupings, the Statewide estimate of the percentage exceeding 55 m.p.h. is derived by the following formula which weights the estimates from each highway grouping by the relative VMT subject to the 55 m.p.h. speed limit of each highway grouping:

$$P_{st} = \sum_{h=1}^{6} W_h P_h$$

where—

P_{st} = Statewide estimate of the percentage exceeding 55 m.p.h.

P_h = percentage estimated for the th highway grouping.

W_h = relative travel (VMT or DVMT) subject to the 55 m.p.h. limit for the h^{th} highway grouping.[9]

Example V–3

Compute the Statewide percentage exceeding 55 m.p.h. based on the following data from the six highway groupings:

(1) Highway Grouping (h)	(2) Relative Travel (W_h)	(3) Estimated Percentage Exceeding 55 m.p.h. (P_h)	(4) Column 2 Times Column 3
1	0.12	80.0	9.600
2	0.10	62.3	6.230
3	0.24	49.6	11.904
4	0.07	79.3	5.551
5	0.17	70.5	11.985
6	0.30	52.1	15.630
Total -	1.00	-	60.9

[8] For control locations this would be the average of the four control sessions (Example V–1).

[9] These are the same or updated figures used in allocating the sample in Chapter III.

The Statewide estimated percentage exceeding 55 m.p.h. is 60.9, the total of column 4.

Standard Deviation of Estimates by Highway Grouping.—The approximate standard deviation of the estimated proportion exceeding 55 m.p.h. of each highway grouping can be derived by the formula:

$$s(p_h) = \sqrt{\left(1 - \frac{n_h}{N_h}\right)\left(\frac{\sum_{i=1}^{n_h} y_{hi}^2 + p_h^2 \sum_{i=1}^{n_h} x_{hi}^2 - 2p_h \sum_{i=1}^{n_h} y_{hi}\, x_{hi}}{n_h\,(n_h - 1)\,\bar{x}_h^2}\right)}$$

where—

$s(p_h)$ = standard deviation of the estimated proportion exceeding 55 m.p.h. of the h^{th} highway grouping.

N_h = number of 5-mile segments subject to the 55 m.p.h. speed limit in the h^{th} highway grouping.

$\bar{x}_h$ = the average of the x_{hi}'s.

n_h, y_{hi}, x_{hi}, and p_h have been defined previously.

The standard deviation of the percentage exceeding 55 m.p.h. can be easily derived by multiplying the above $s(p_h)$ by 100.

Example V–4

Compute the standard deviation of the percentage exceeding 55 m.p.h. using the data in Example V–2.

BILLING CODE 4910-22-M

(1)	(2)	(3)	(4)	(5)	(6)
Location Number (i)	Number of Vehicles Exceeding 55 m.p.h. (y_{1i})	Column (2) Squared (y_{1i}^2)	Total Vehicles Measured (x_{ni})	Column (4) Squared (x_{hi}^2)	Column (2) Times Column (4) ($y_{hi}x_{hi}$)
1	2,971	8.826×10^6	6,119	37.442×10^6	18.180×10^6
2	2,069	4.281×10^6	4,484	20.106×10^6	9.277×10^6
3	5,361	28.740×10^6	7,949	63.187×10^6	42.615×10^6
4	12,561	157.779×10^6	15,412	237.530×10^6	193.590×10^6
5	8,631	74.494×10^6	12,703	161.366×10^6	109.640×10^6
6	1,921	3.690×10^6	4,918	24.187×10^6	9.447×10^6
7	2,168	4.700×10^6	4,682	21.921×10^6	10.151×10^6
Total 7	35,682	282.510×10^6	56,267	565.739×10^6	392.900×10^6

For the purposes of this example, assume that the total number of segments in this highway grouping is 1,500, then using the table above:

$1 - n_1/N_1 = 1 - 7/1500 = 0.995$

$\sum_{i=1}^{7} y_{1i}^2 = 282.510 \times 10^6$, the total of column (3)

$P_1 = 0.634$ from Example V-2

$\sum_{i=1}^{7} x_{1i}^2 = 565.739 \times 10^6$, the total of column (5)

$\sum_{i=1}^{7} y_{1i}\, x_{1i} = 392.900 \times 10^6$, the total of column (6)

and $\bar{x}_1 = 8.038 \times 10^3$, the total of column (4)

divided by n_1 ($n_1 = 7$)

completing the formula

$$s(p_1) = \sqrt{\frac{(.995)\left[282.510 + (.634)^2(565.739) - 2(.634)(392.900)\right]}{7(6)\,(8.038)^2 \times 10^6} \times 10^6}$$

$$= \sqrt{.00429}$$

$$= 0.0655$$

The standard deviation of the percentage of highway grouping 1 is obtained by multiplying this last value by 100.

$s(P_1) = 6.55$ percent.

Statewide Standard Deviation Estimate.—Once values have been computed for each of the applicable highway groupings, a Statewide standard deviation estimate is derived by the following formula:

$$s(P_{st}) = \sqrt{\sum_{h=1}^{6} W_h^2 \left[s(P_h)\right]^2}$$

where

$s(P_{st})$ = standard deviation of the estimated Statewide percentage of vehicles exceeding 55 m.p.h.

W_h = relative travel (VMT or DVMT) subject to the 55 m.p.h. limit on the h_{th} highway grouping.

$s(P_h)$ = standard deviation of the estimated percentage exceeding 55 m.p.h. for the h^{th} highway grouping.

Example V-5

Compute the Statewide standard deviation of the estimated percentage of vehicles exceeding 55 m.p.h. using the data in the following table.

(1)	(2)	(3)	(4)	(5)	(6)
Highway Grouping (h)	Relative VMT (W_h)	Standard Deviation of the Percentage Exceeding 55 m.p.h. $[s(P_h)]$	Column (2) Squared $[W_h^2]$	Column (3) Squared $[s(P_h)]^2$	Column (4) Times Column (5)
1	0.12	6.55	0.0144	42.90	0.6178
2	0.10	12.32	0.01	151.78	1.5178
3	0.24	11.15	0.0576	124.32	7.1608
4	0.07	8.60	0.0049	73.96	0.3624
5	0.17	9.30	0.0289	86.49	2.4996
6	0.30	14.70	0.09	216.09	19.4481
Total -	1.0	-	-	-	31.6065

The total of column (6) is the variance, and the standard deviation is 5.6, the square root of the variance. The subsequent section uses this number to determine the statistical reliability of the sample.

BILLING CODE 4910-22-C

Reliability of Statewide Estimates.—The actual statistical precision achieved can be estimated by computing confidence intervals. The magnitude of an approximate one-sided 95 percent confidence interval of the estimate assuming a normal distribution of speeds is given by:

$$d = t_{.95,n}\, s(P_{st})/\sqrt{n}$$

where—

d = actual precision achieved.

$t_{.95,n}$ = value of student's t distribution with $\alpha = 0.05$ and n, the number of Statewide monitoring locations.

$s(P_{st})$ = standard deviation of the Statewide percentage exceeding 55 m.p.h.

n = number of monitoring locations.

Since a 2.0 target precision was used to determine the initial sample size, this is an easy way of determining whether the sample size needs to be adjusted. If the interval computed is less than or equal to 2.0, then no change to the Statewide number of locations is needed.

The initial sample size was based on the concepts of reliability and coverage. For those States where the coverage concept was the deciding factor in selecting sample size, it is unlikely that any change in sample size will be needed. For States, where the reliability concept decided the sample size or for borderline States where the numbers under both concepts were similar, increases or decreases may be needed. Increasing the sample size to meet the reliability requirement is mandatory while decreasing the sample size is optional.

Example V–6

Compute the precision achieved based on the data in Example V–5. The standard deviation from Example V–5 is 5.6. The value of the t statistic with a 95 percent confidence level and n = 40 is 1.684. The interval then is $1.684 \times 5.6/\sqrt{40}$ which equals 1.5. This means that the actual precision is better than the target criteria, and therefore, no adjustment to the sample size for the next year is required.

Sample Size Determination Based on Data Analysis

This procedure is only required for States not meeting the target sampling precision (2.0) of the estimated "Statewide percentage exceeding 55 m.p.h." The procedure is analogous to that presented in Chapter III. The only difference is that values are computed using the actual data collected during the previous year.

The sampe size formulas (reliability requirement) are:

$$n_o = \left[\frac{t_{.95,n}\, s(P_{st})}{d}\right]^2$$

$$n_p = \frac{n_o}{1 + n_o/N}$$

where—

n_o = infinite population sample size.

$t_{.95,n}$ = value of student's t statistic based on a 95 percent one-sided confidence interval and with n (the number of locations sampled during the previous year) degrees of freedom.

$s(P_{st})$ = standard error of the estimated Statewide percentage exceeding 55 m.p.h. (page V–6) for a stratified cluster sample.

d = target precision (2.0).

n_p = Statewide minimum sample size under "accuracy concept".

N = number of highway segments in the State (Statewide frame size).

As in Chapter III, the sample size under the "coverage concept" must be computed. The Statewide sample size would then be the larger of the two values obtained from the two concepts. [10] The rules for determining the number of total and control locations, to be monitored in each highway grouping, remain the same. The formula for allocation to highway grouping is on page III–9. Control sampling locations have been discussed on pages III–2 and III–11.

If an increase of monitoring locations for the coming year is required, then the added locations must be selected according to the procedures in Chapter III. Locations selected during the initial year remain permanent.

The procedure described in this section is not required for States that attain the target reliability. However, the procedure can be applied to reduce sample size if desired. Minor reductions are not recommended because of the variability of data from year to year. They may well result in a decrease of a few locations one year and an increase of a few the next, which would necessitate needless adjustment of the procedures each year.

Example V–7

Determine the new sample size under the "reliability concept" using the data from Example V–5, assuming a Statewide frame size of 1,500 segments and a sample size of 40 locations.

Substituting values in the formulas,

$$n_o = \left[\frac{1.684 \quad (5.6)}{2.0}\right]^2 = 23$$

$$n_p = \frac{23}{1 + 23/1500} = 23$$

Therefore, 23 locations would be needed during the coming year to meet the reliability requirement. To determine the Statewide sample size, it is necessary to determine the number of locations needed under the coverage concept, and then to select the larger of the two numbers.

Computation of Other Statistics

The statistics discussed in this section are average speed, median speed, 85th percentile speed, and proportions exceeding specific speeds. The data on which these estimates are based are collected at control locations according to the procedures in Chapter III. Since the number of control locations is not very large, the accuracy levels of these estimates will not match that achieved for the percentage exceeding 55 m.p.h. estimates. However, computing these estimates by highway grouping and for the State as a whole will present a much better picture of the actual characteristics of the population of speeds. Since one purpose of the national speed limit is to improve safety by enforcing motorist compliance, a

[10] The "coverage concept" sample size must be based on the latest available figures on travel (DVMT).

valuable tool will be provided to aid in the planning of safety or enforcement activities.

The discussion will concentrate on the average, median and 85th percentile speeds only. Statistics regarding the proportions exceeding 60 m.p.h., 65 m.p.h. or any other speed can be derived using exactly the same procedure presented in the previous sections by simply using the proportion exceeding the desired speed instead of the proportion exceeding 55 m.p.h.

To compute the session statistics, two procedures will be presented which deal with the two possible alternatives of individual speeds or groups of speeds. The simplest and most statistically sound method of data collection would be to collect individual speeds for a 24-hour period at each session. However, equipment and other considerations may result in the collection of groups of speeds.

Session Average or Mean Speed.—For each control session the average speed is computed by summing the speeds of all vehicles sampled dividing by the number of vehicles sampled. If groups of speeds were collected, the mean speed is derived by multiplying the midpoint of each group by the number of vehicles in each group, summing all groups, and dividing the total by the total number of vehicles. This procedure assumes equal group intervals and a uniform distribution of speeds within groups.

Example V–8

A worksheet approach is presented to compute the average speed of grouped data from a control session.

(1) Speed Group	(2) Number of Vehicles	(3) Midpoint	(4) Col.(2) x Col.(3)
41–45	200	43	8,600
46–50	250	48	12,000
51–55	550	53	29,150
56–60	450	58	26,100
60–65	350	63	22,050
66–70	300	68	20,400
71–75	200	73	14,600
Total -	2,300	-	132,900

The average speed is the total of column 4 divided by the total of column 2, or $\frac{132,900}{2,300}$ which equals 57.8 m.p.h.

Session Median Speed.—The median speed or 50th percentile speed of each control session is defined as the speed value which divides the distribution so that 50 percent of the vehicles measured were traveling below that speed value. For individual speed data, the median is the middle value when speeds are ordered according to magnitude. If the number of vehicles is even, then average the two middle values.

Example V–9

Compute the median of the following two sets of numbers—

3 5 7 9 11 13 15 17 19

and

3 5 7 9 11 13 15 17 19 21

There are nine values in the first set, and hence, the middle is the fifth. The fifth value (11) is the median. For the second set the middle values are 11 and 13 and the median is the average 12. This example also illustrates that the median is not necessarily one of the given values.

For grouped speed data it is necessary to determine in which group the middle value falls and then to proportionately allocate the middle value within that group. Example V–10 presents a worksheet which can be used for this purpose.

Example V–10

Compute the median of the data in Example V–8

(1) Speed Group	(2) Number of Vehicles	(3) Cumulative Frequency
41–45	200	200
46–50	250	450
51–55	550	1,000
56–60	450	1,450
61–65	350	1,800
66–70	300	2,100
71–75	200	2,300

The middle value is the 1,150th value (2300 divided by 2). From the cumulative frequency column, the 1,150th value is in the 56–60 speed group. There are 450 values in that class and therefore the interval allocation for the 150th value (1150–1000) is 150/450 (⅓) times the group interval (⅓ × 5). The median is then the lower value of the group plus one-third of the group interval (56 + ⅔ = 57.7). This procedure assumes a uniform distribution of values within each group interval.

Session 85th Percentile Speed.—The 85th percentile speed is the speed value at or below which 85 percent of the vehicles were traveling. For individual speed data ordered by speed magnitude, it is the value of the observation determined by multiplying the total number of vehicles sampled by 0.85. For grouped data it is computed by the same procedure as the median.

Example V–11

Compute the 85th percentile of the data in Example V–10. The 85th percentile observation is the 1955th observation (2300 × .85 = 1955). From the

cumulative frequency in Example V–9, it falls in the 66–70 group. Then proportion the interval (1955–1800 ÷ :2100–1800 × 5 = 2.6) and the estimated 85th percentile is 68.6 m.p.h. (66 + 2.6 = 68.6).

Highway Functional Grouping and Statewide Estimates.—Data for each control session within a highway functional grouping should be combined to form a composite data set. Then the mean, median, and percentile speeds can be estimated by using the same procedures presented for the estimation of session statistics. Statewide estimates can be derived in the same manner by combining the data from all control sessions to form a Statewide composite data set and applying the same session procedures or alternatively weighing each functional grouping as done on page V–4 for the percentage exceeding 55 m.p.h.

Specialized Analysis

Based on the fact that quarterly measurements were taken at each control location, it is possible to develop estimates by quarter which can be used to determine the extent of seasonal variation. All of the procedures which have been presented in previous sections are as applicable to annual as to quarterly data. The data collected from standard sessions can also be used for this purpose. However, since the measurements were made at different locations, the seasonal differences will be confounded [11] by locational differences. In the same light, these types of analyses can be conducted by month, day of the week, or geographical location within a State depending, of course, on the manner in which the measurement sessions were arranged and on the method of data collection.

VI. Reporting Results

Summary speed statistics from each State's monitoring program are required to be submitted to FHWA as part of the annual certification of 55 m.p.h. speed limit enforcement. In addition, regulations require a continuation of the current practice of submitting quarterly reports showing results of monitoring during the previous 3-month period. The Statewide value of "percent of motor vehicles exceeding 55 m.p.h." calculated to represent all traffic throughout the State is the critical statistic required in a State's annual certification. Figure VI–1 shows the desired format for reporting both annual and quarterly speed summary data. In the annual certification, the following data must be reported for each *functional group:*

- Weighting factor for calculating Statewide values (calculated from system VMT subject to the 55 m.p.h. speed limit).
- Highway mileage with a legal speed limit of 55 m.p.h.
- Number of monitoring locations. Show in parentheses the number of control locations where detailed speed data were collected.
- Number of vehicles measured.
- Percent of vehicles exceeding 55 m.p.h.
- Percent of total Statewide vehicle miles of travel on facilities with a legal speed limit of 55 m.p.h.

Based on control locations where more detailed data are collected, the following data will be collected and shall be reported using the same format in Figure VI–1:

- Average speed.
- Median speed.
- 85th percentile speed.
- Percent of vehicles exceeding 60 m.p.h.
- Percent of vehicles exceeding 65 m.p.h.

Individual session reports can be useful at the State level for identifying locations warranting increased enforcement activity. Although reporting of these session statistics is not required, States should maintain these data in their files for a minimum of 3 years following the year of collection.

Billing Code 4910–22–M

[11] In statistical terminology confounding indicates that effects cannot be differentiated.

SPEED SUMMARY REPORT

Send to Office of Highway Planning HHP-44
QUARTERLY REPORT - CALENDAR QUARTER ENDING _____

STATE _____ (3 4 5 6 7) (State Code, Quarter, Year)

SYSTEM	CARD NO.	VMT WEIGHTING FACTOR	MILES	NO. OF SESSIONS	NO. OF VEHICLES OBSERVED	PERCENT EXCEEDING 55 MPH	SPEED			PERCENT EXCEEDING	
							AVERAGE	MEDIAN	85TH PER-CENTILE	60 MPH	65 MPH
URBAN INTERSTATE	(1-2) 10	(8-11)	(12-17)	(18-20)	(21-26)	(27-30)	(31-34)	(35-38)	(39-42)	(43-46)	(47-50)
URBAN OTHER FREEWAY & EXPRESSWAYS	(1-2) 20	(8-11)	(12-17)	(18-20)	(21-26)	(27-30)	(31-34)	(35-38)	(39-42)	(43-46)	(47-50)
URBAN OTHER PRINCIPAL ARTERIALS AND MINOR ARTERIALS	(1-2) 30	(8-11)	(12-17)	(18-20)	(21-26)	(27-30)	(31-34)	(35-38)	(39-42)	(43-46)	(47-50)
RURAL INTERSTATE	(1-2) 40	(8-11)	(12-17)	(18-20)	(21-26)	(27-30)	(31-34)	(35-38)	(39-42)	(43-46)	(47-50)
RURAL OTHER PRINCIPAL ARTERIALS AND MINOR ARTERIALS	(1-2) 50	(8-11)	(12-17)	(18-20)	(21-26)	(27-30)	(31-34)	(35-38)	(39-42)	(43-46)	(47-50)
RURAL MAJOR COLLECTORS	(1-2) 60	(8-11)	(12-17)	(18-20)	(21-26)	(27-30)	(31-34)	(35-38)	(39-42)	(43-46)	(47-50)
STATEWIDE TOTALS	(1-2) 70	(8-11)	(12-17)	(18-20)	(21-26)	(27-30)	(31-34)	(35-38)	(39-42)	(43-46)	(47-50)

PERCENT OF TOTAL STATEWIDE VMT ON FACILITIES WITH 55 MPH SPEED LIMITS (51 52 53 54)

[FR Doc. 80-30178 Filed 9-26-80; 8:45 am]
BILLING CODE 4910-22-C